THE ENGINEER

MAY 13, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

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of engineering

The task undertaken by this 19-RB diesel shovel is widening a mountain road in Norway; a high altitude job in tough and unusual conditions where dependability is of utmost importance.

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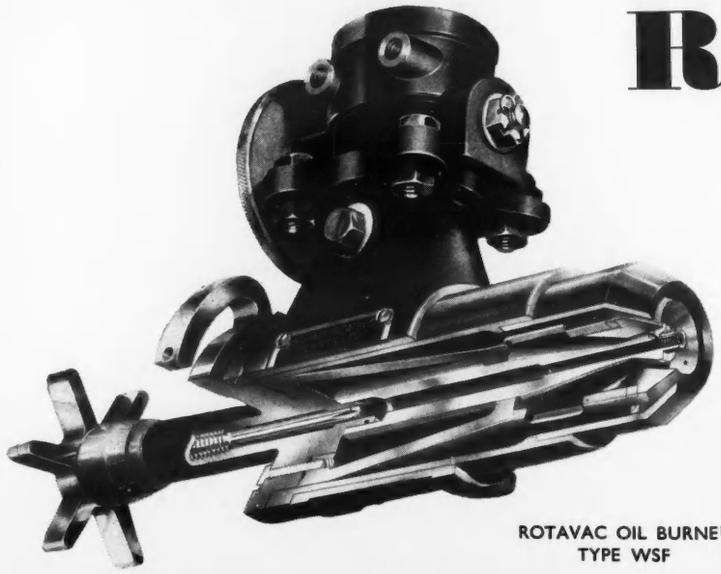

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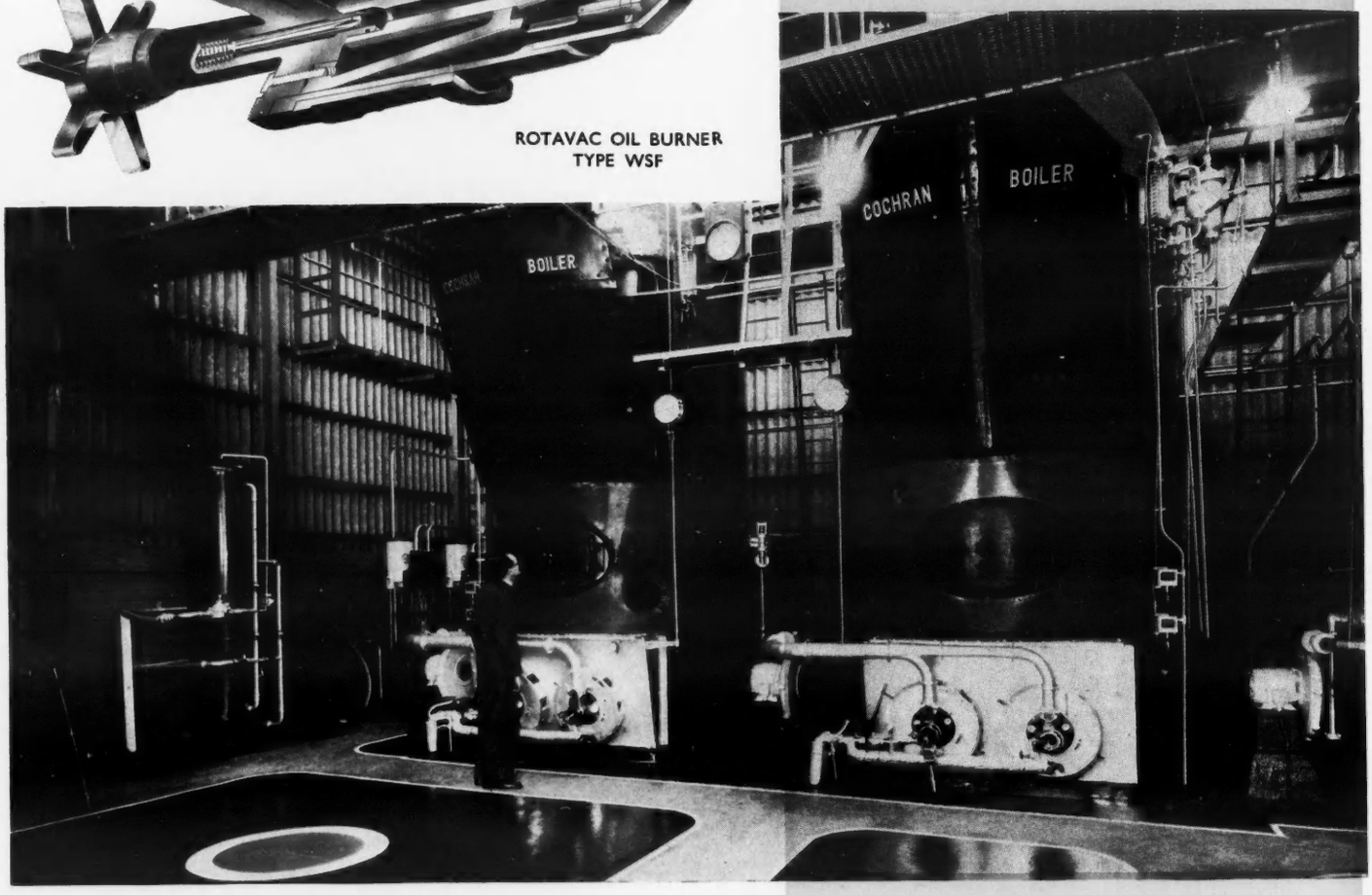

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Established 1856

No. 5442 MAY 13, 1960 VOL. 209

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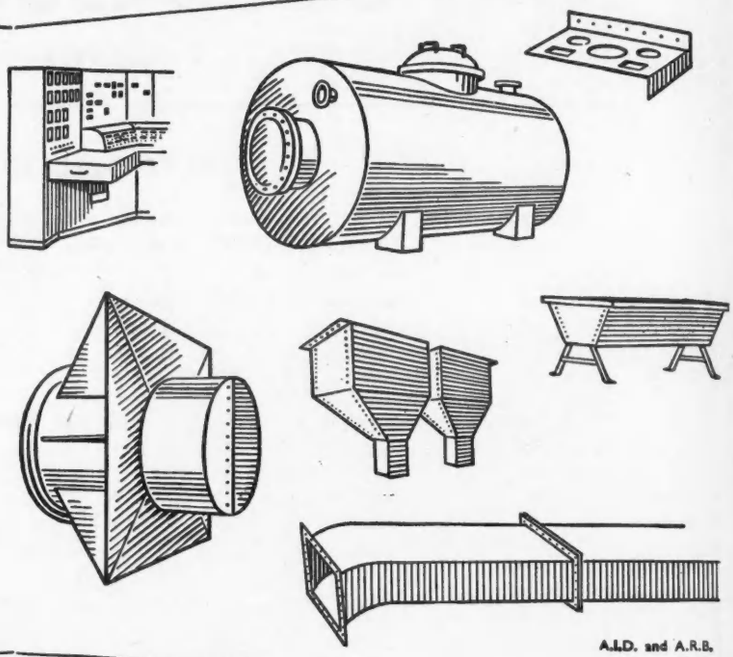

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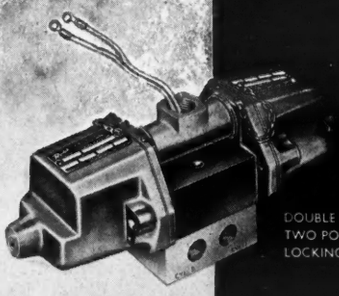

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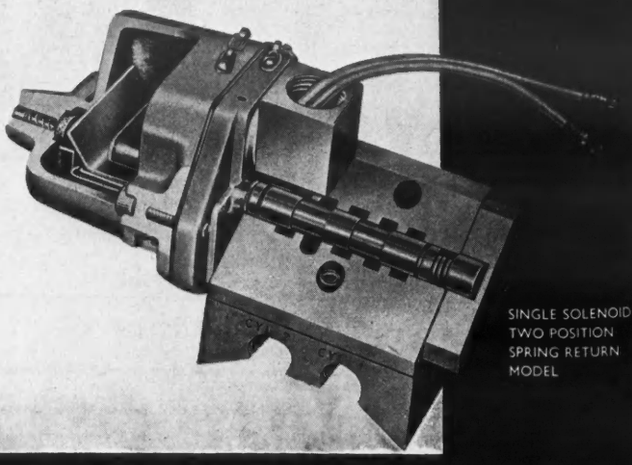

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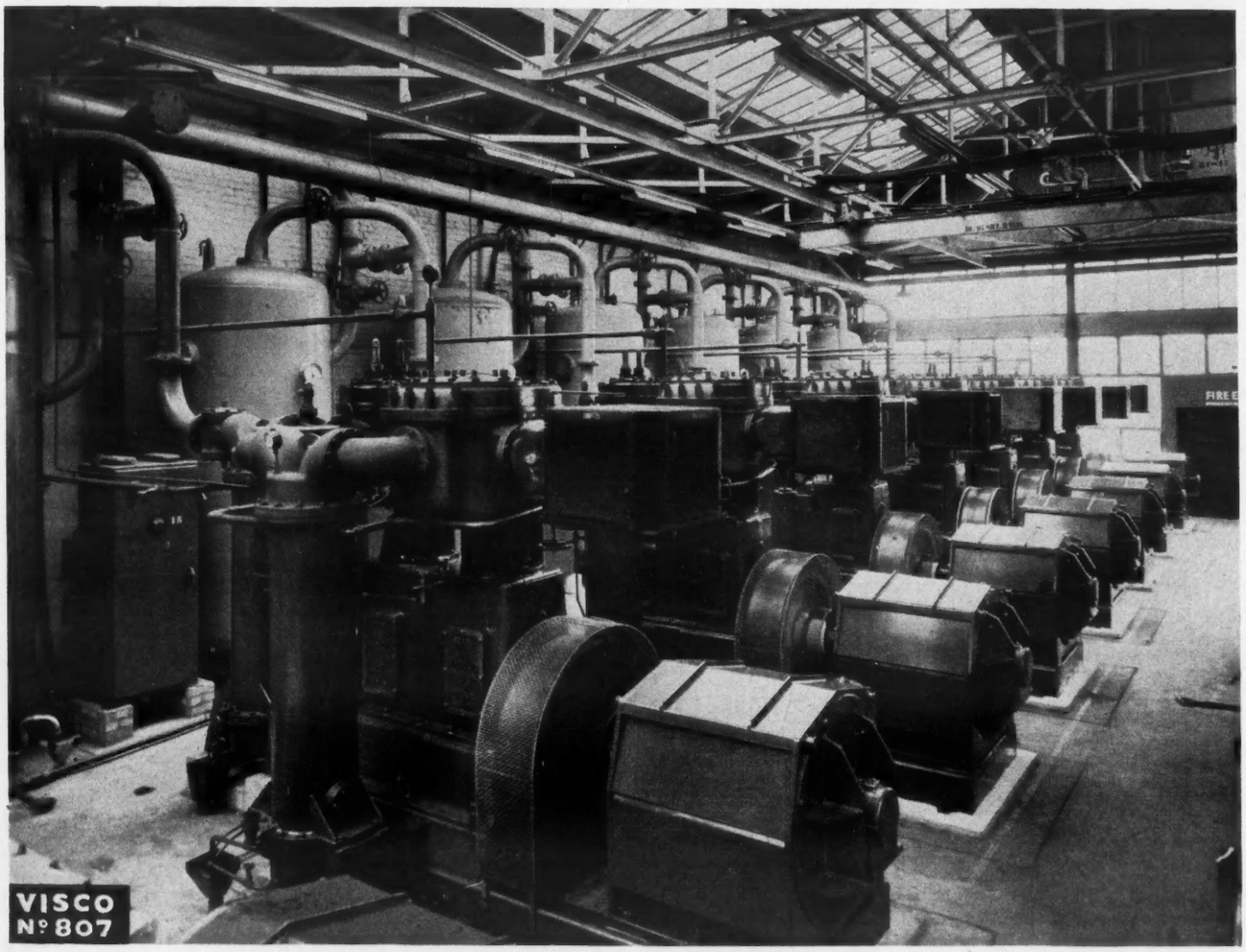

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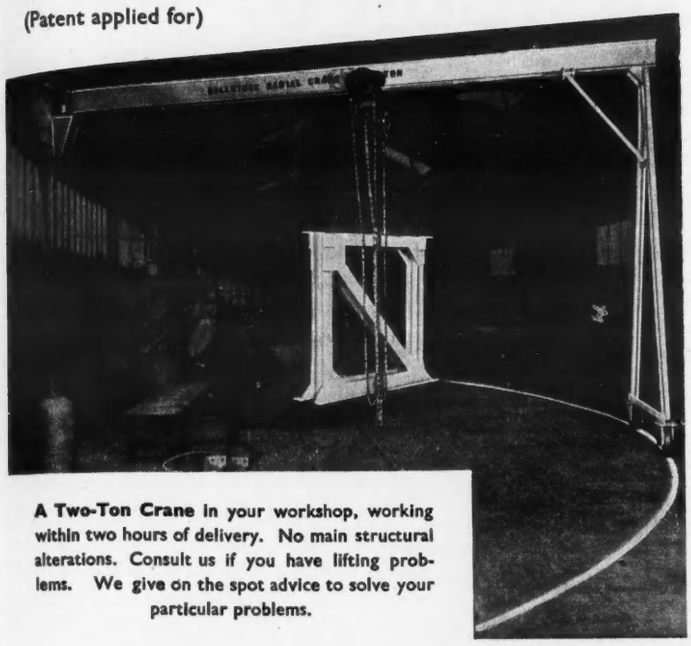

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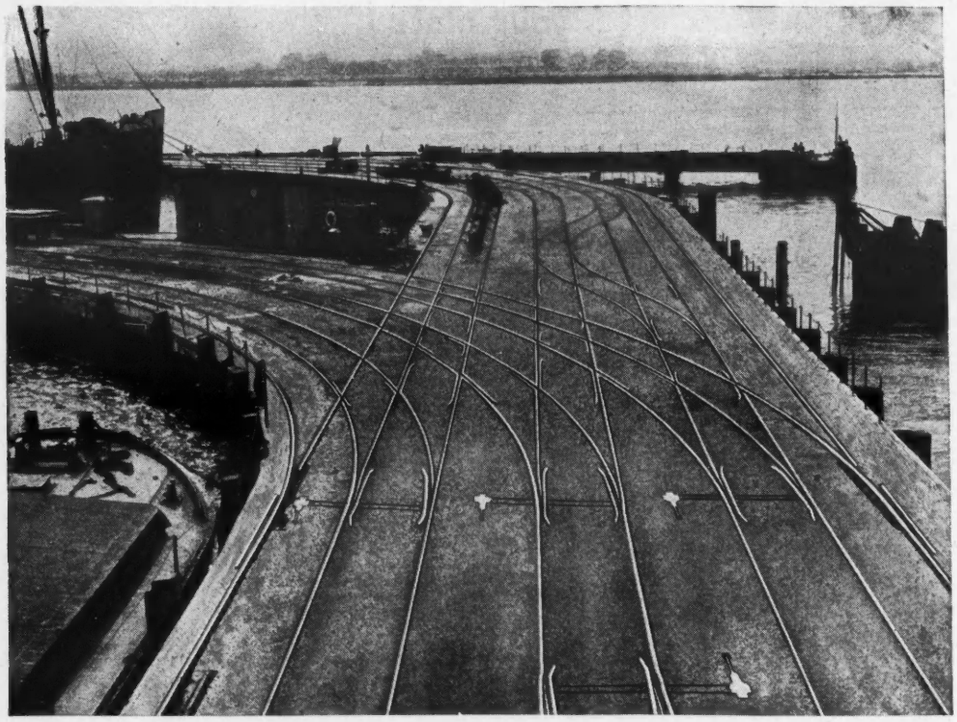

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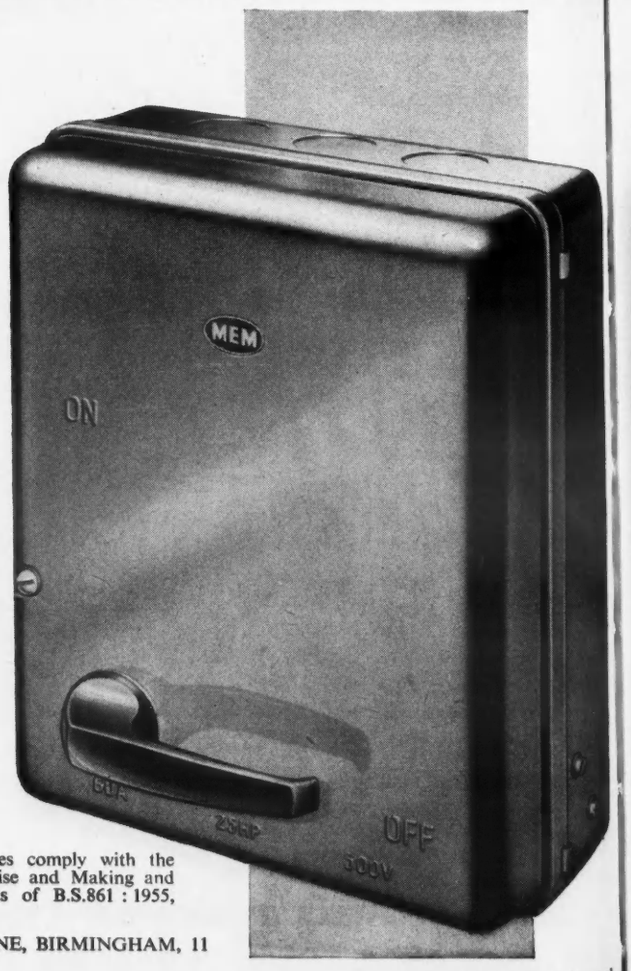

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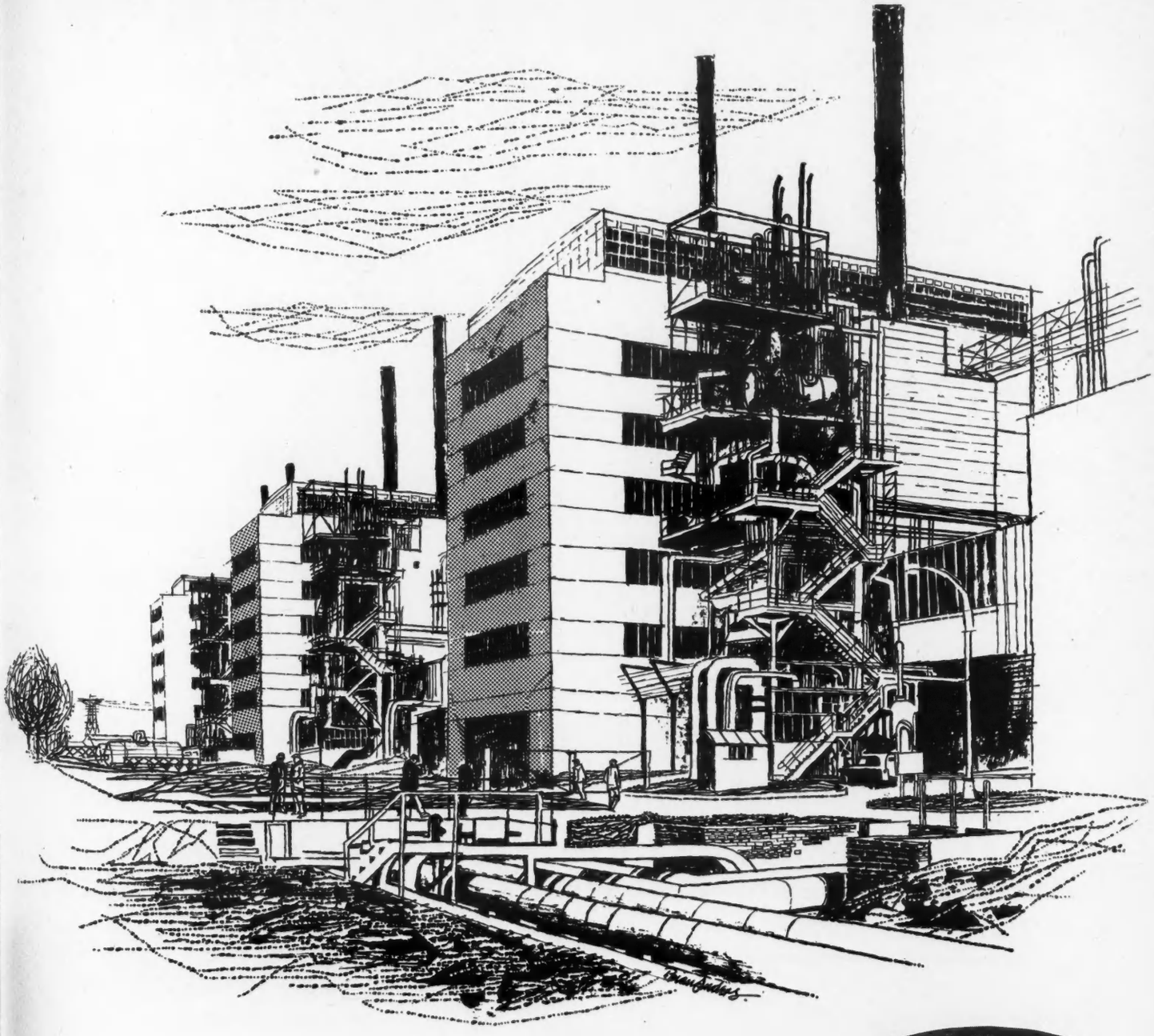

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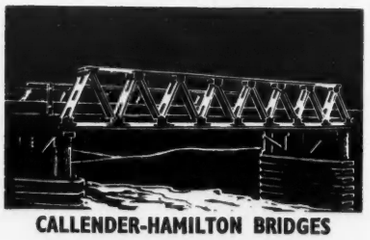

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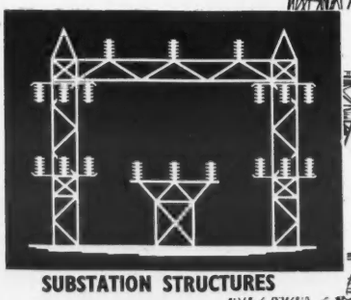

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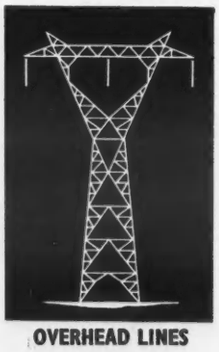

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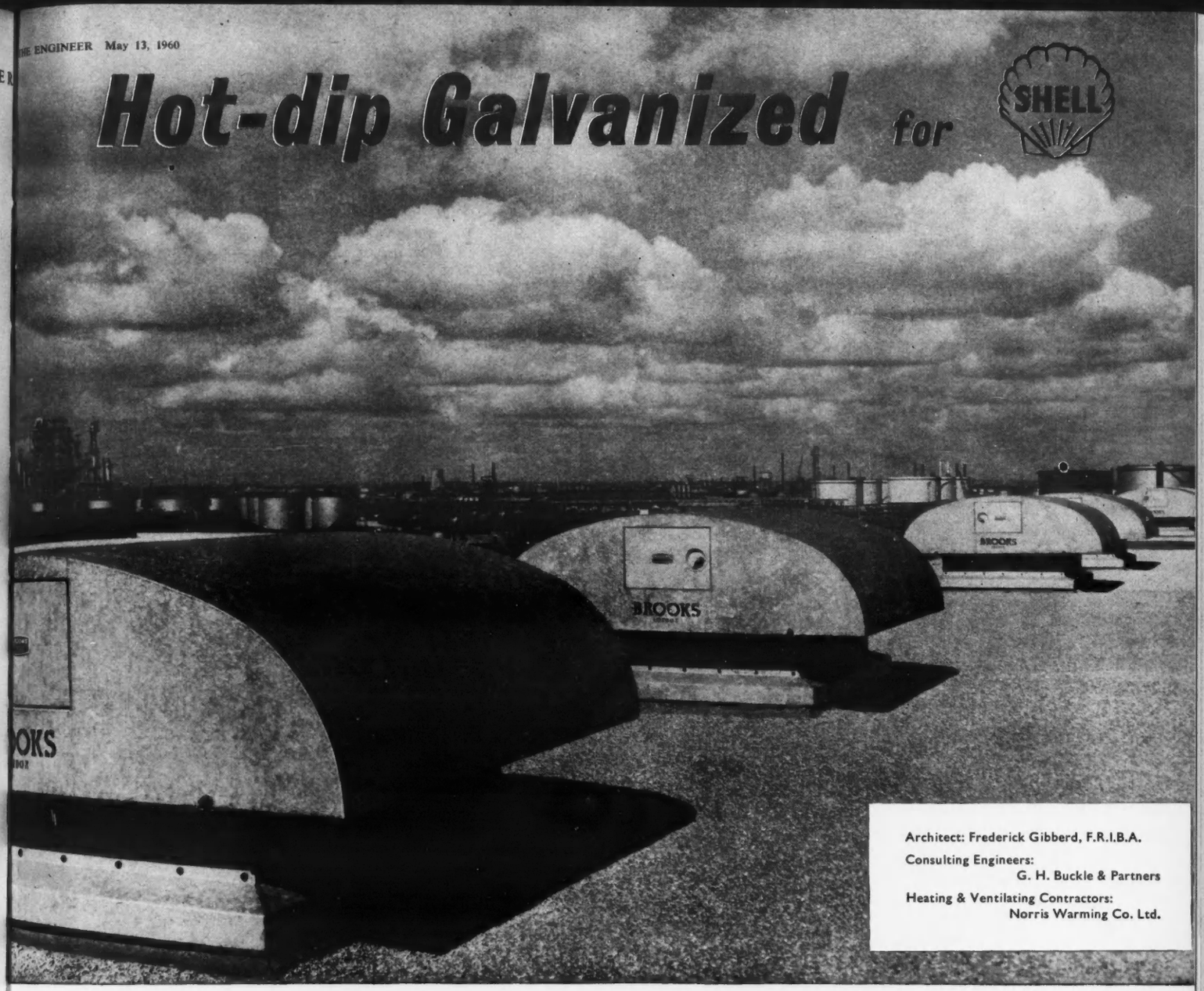

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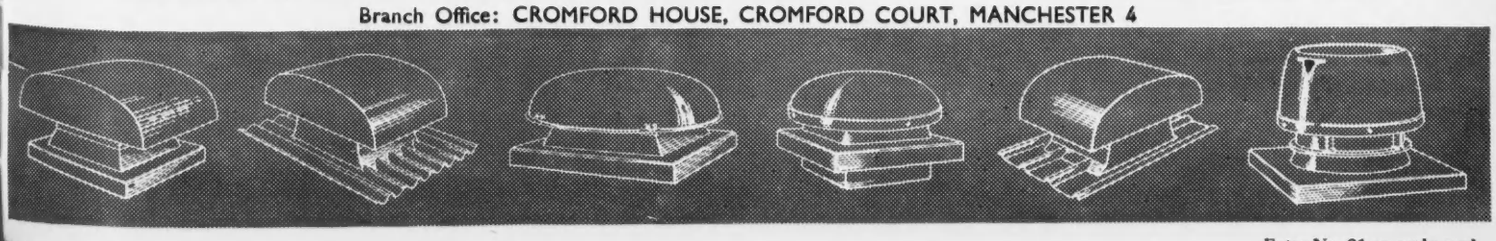

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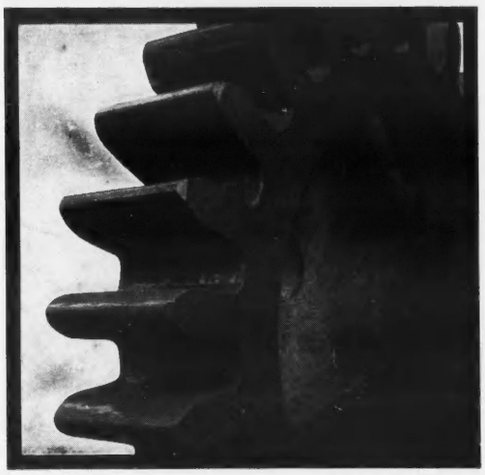

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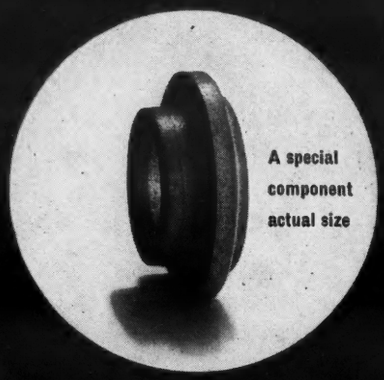

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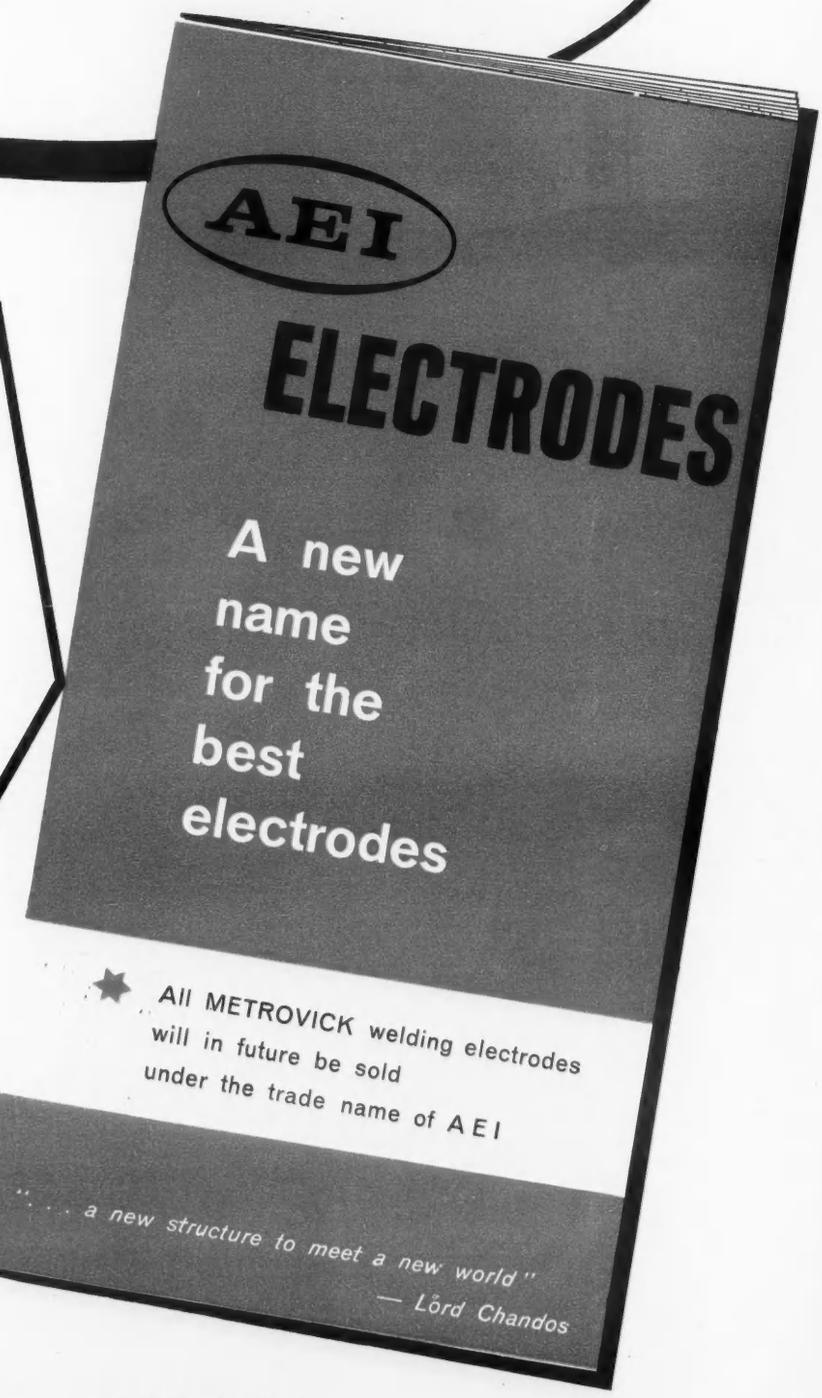
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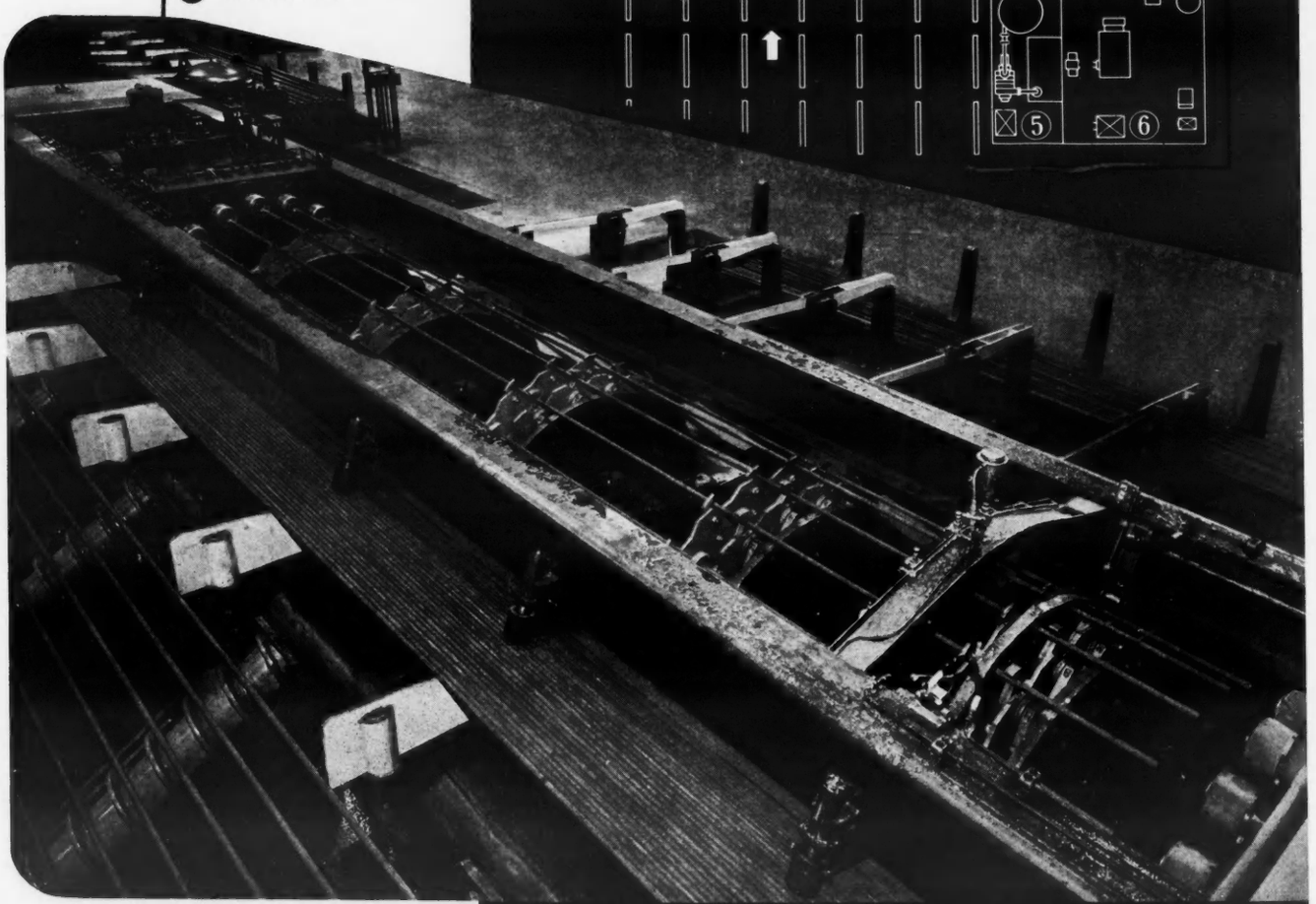

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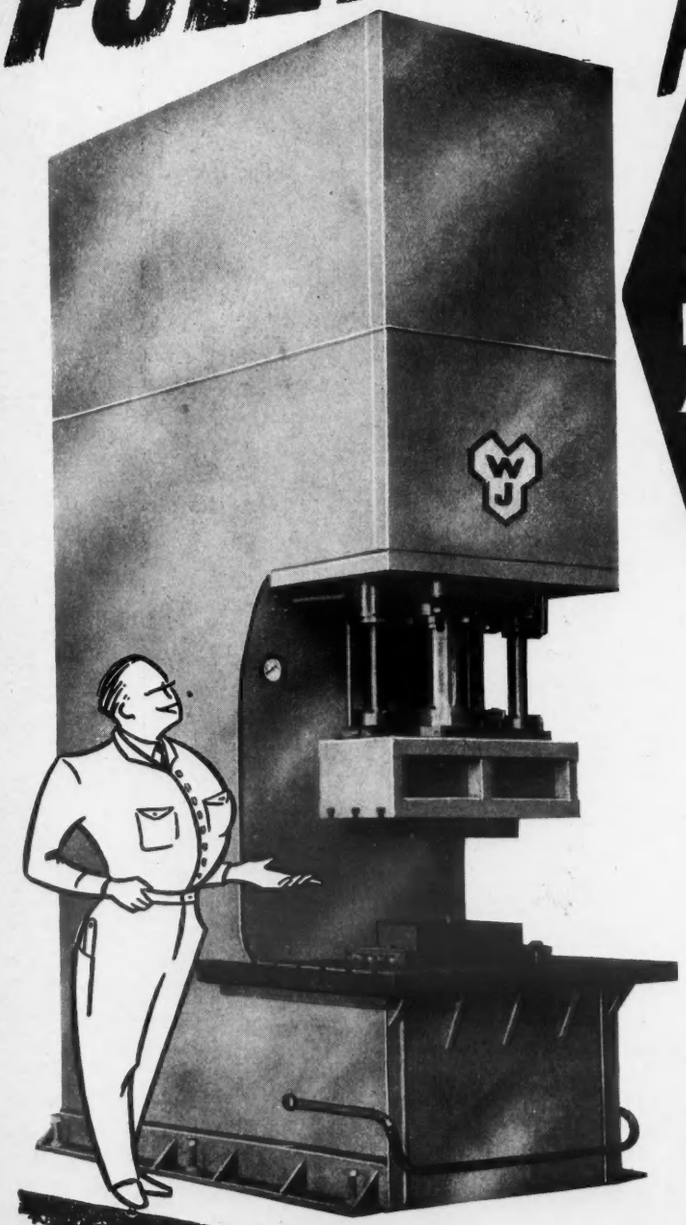

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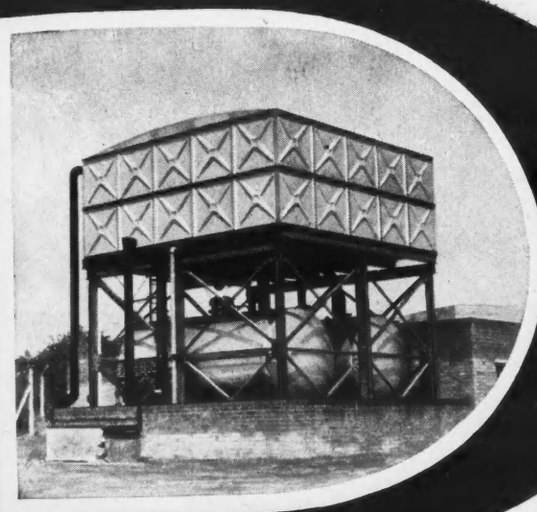

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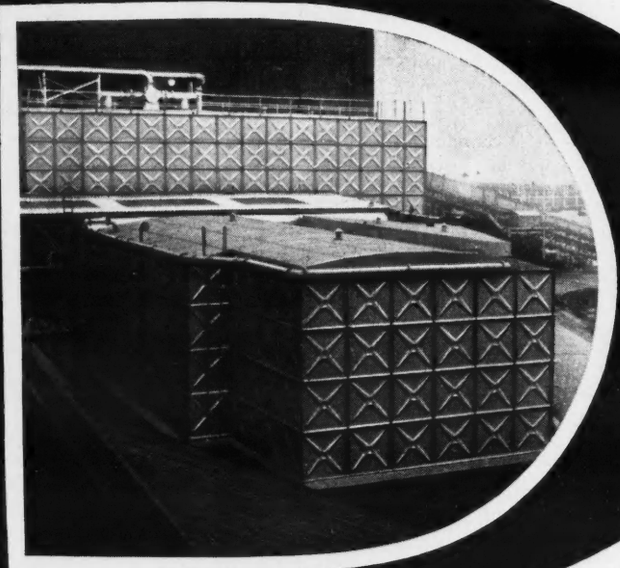

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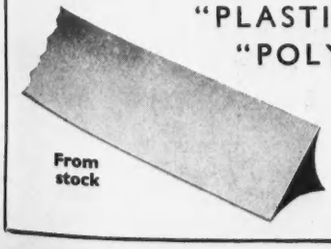

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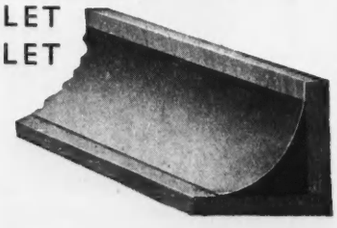

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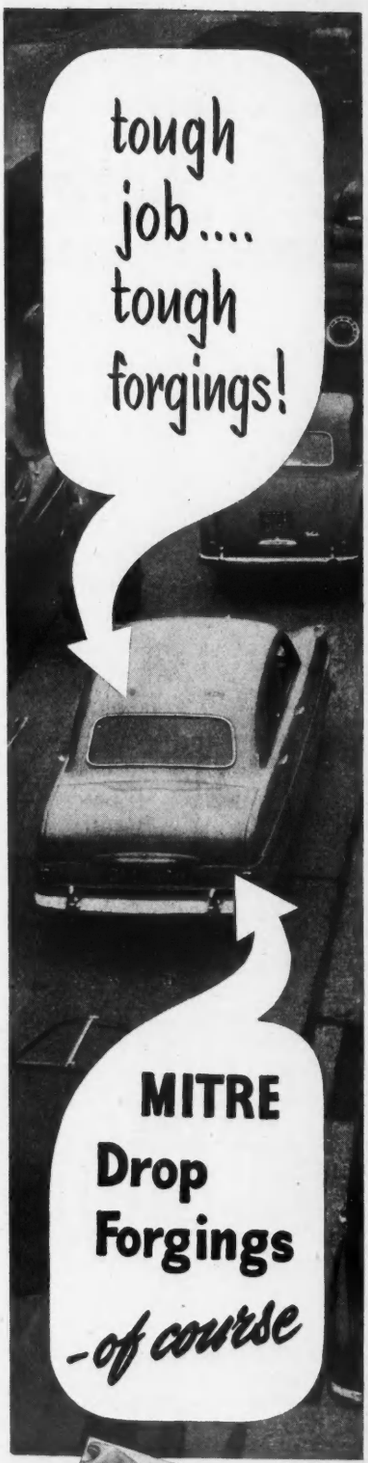

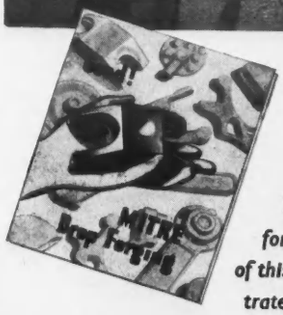

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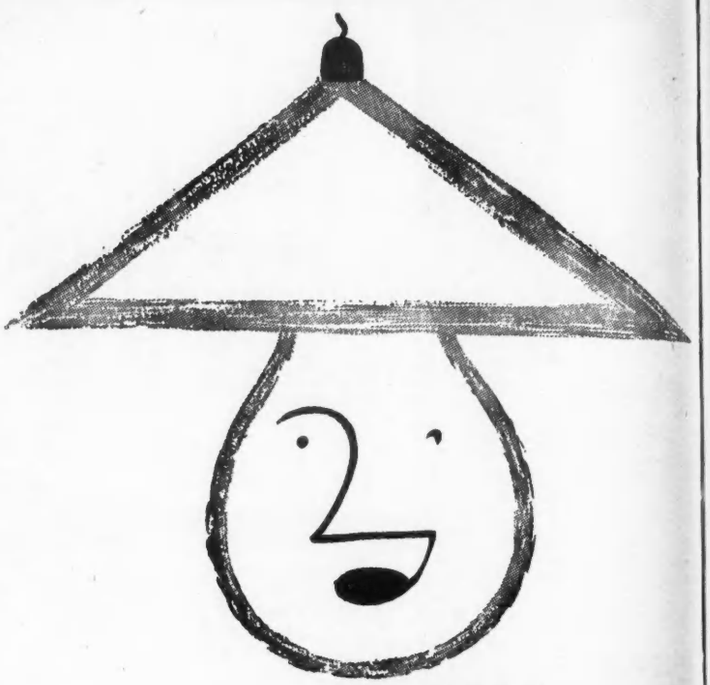

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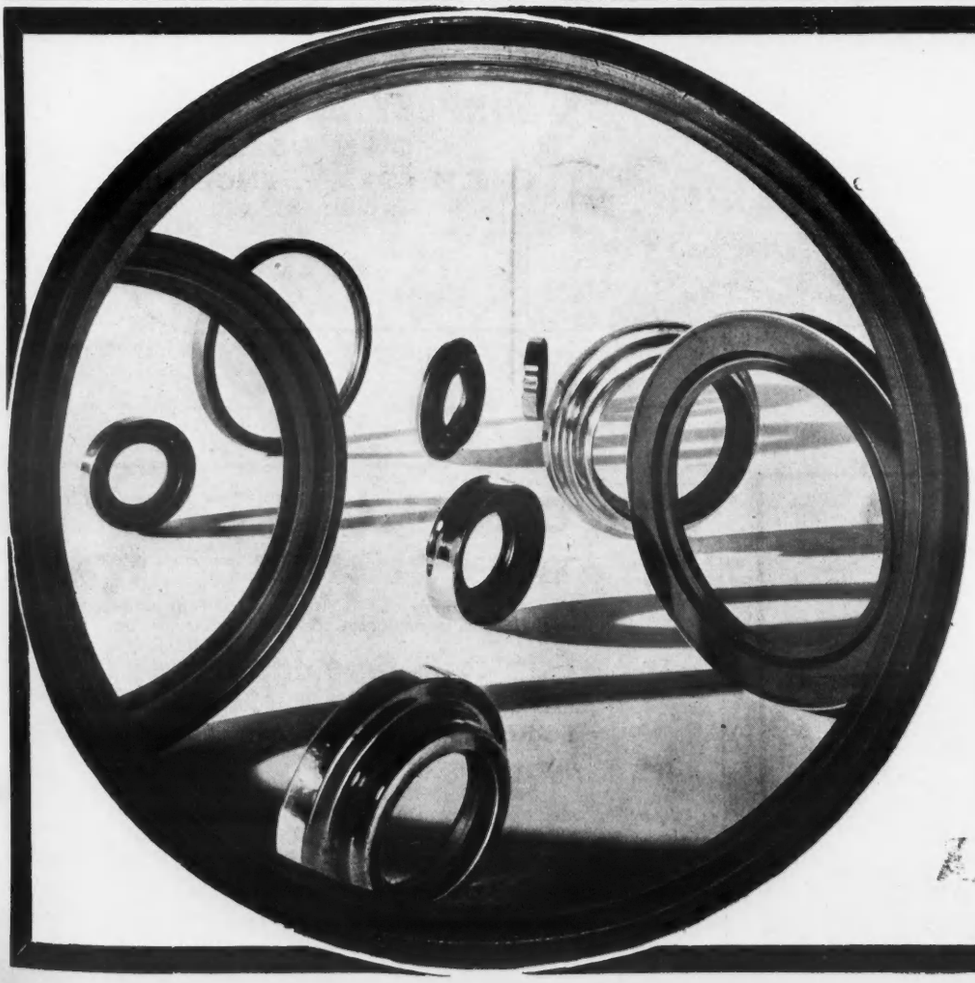

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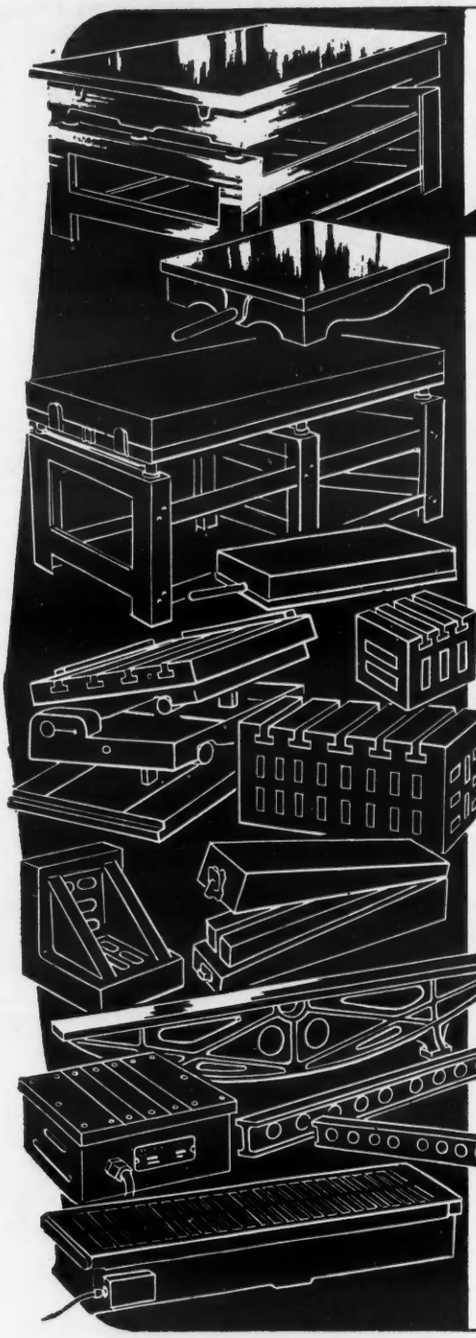

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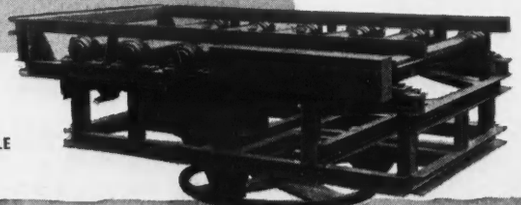

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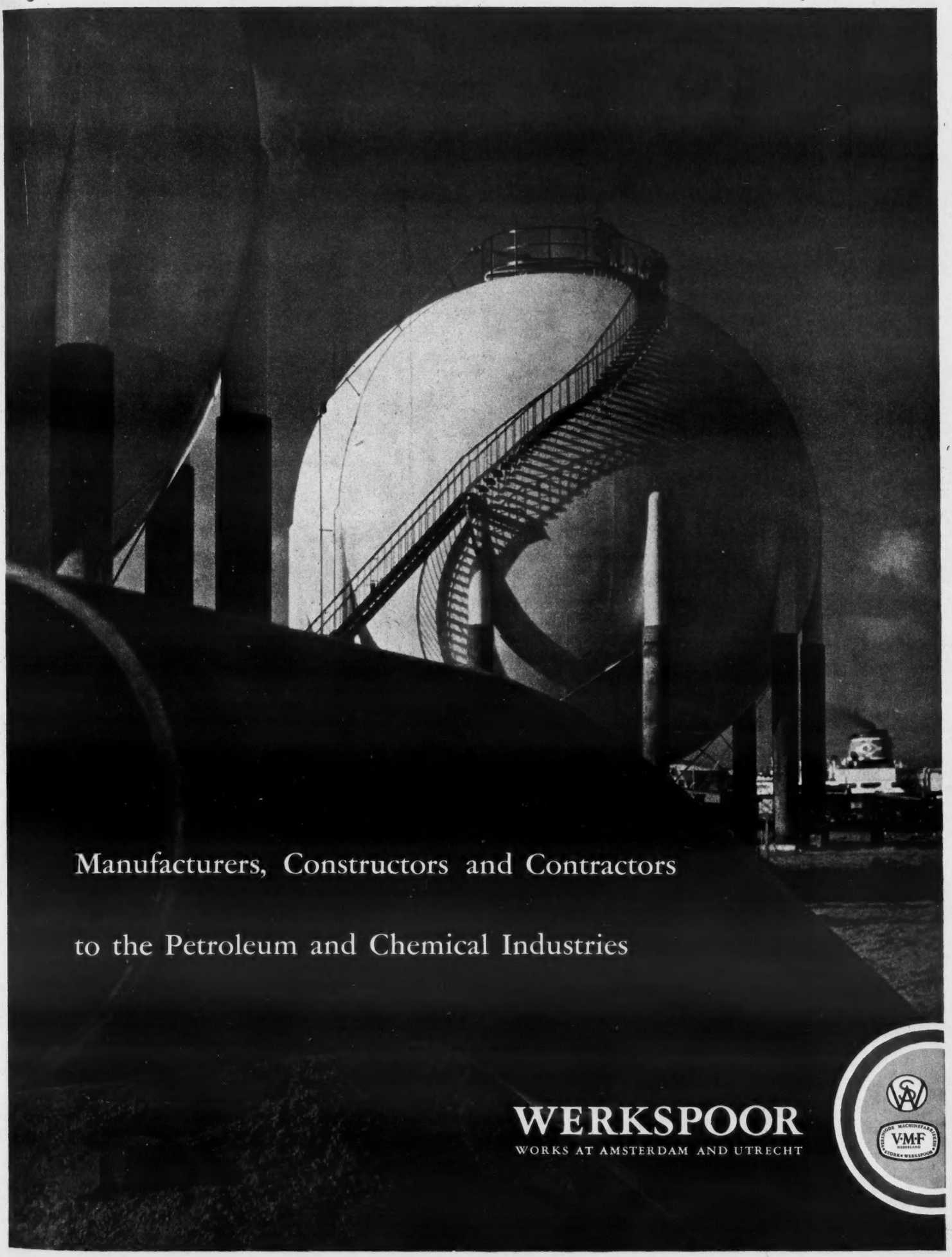

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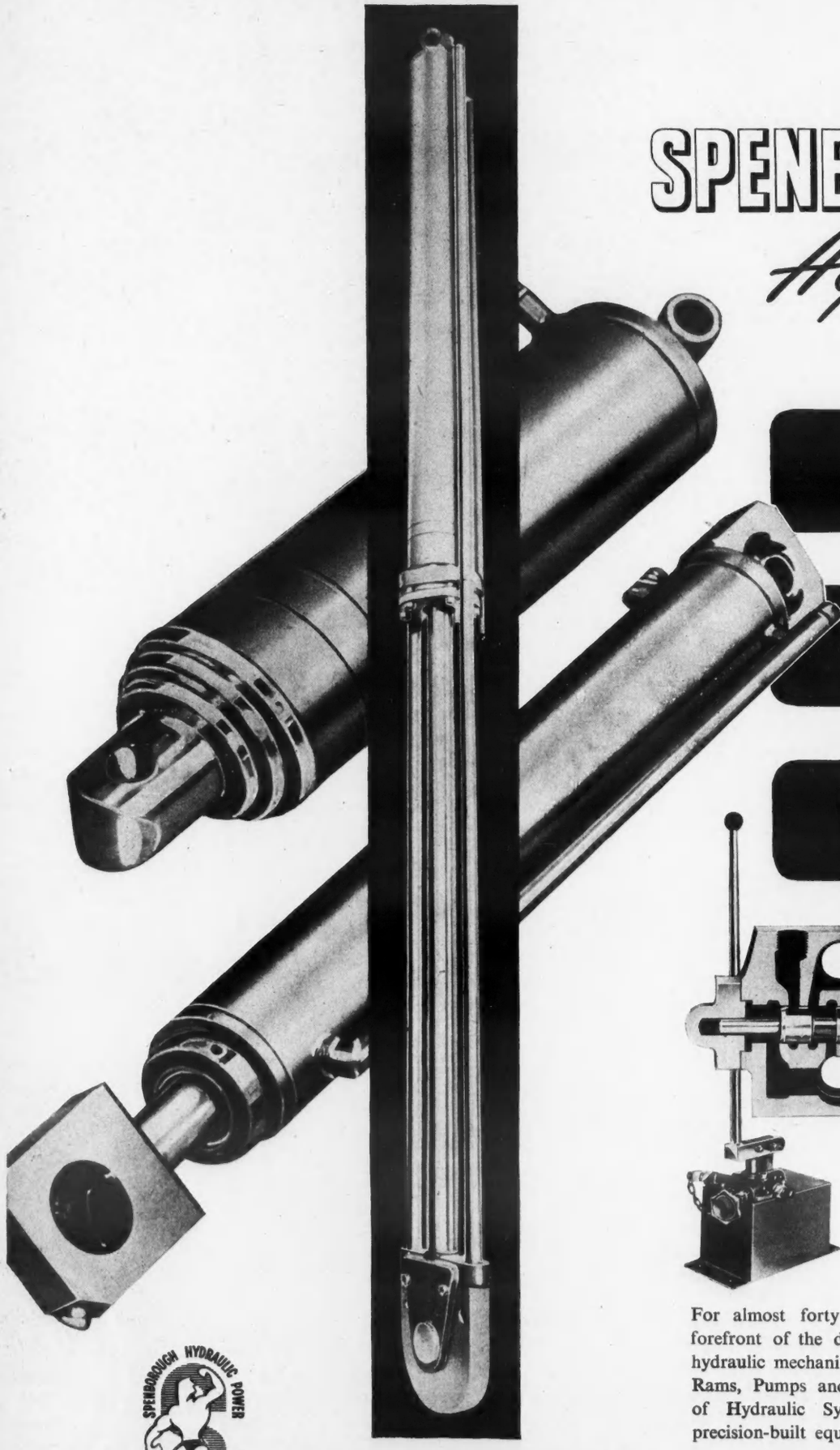

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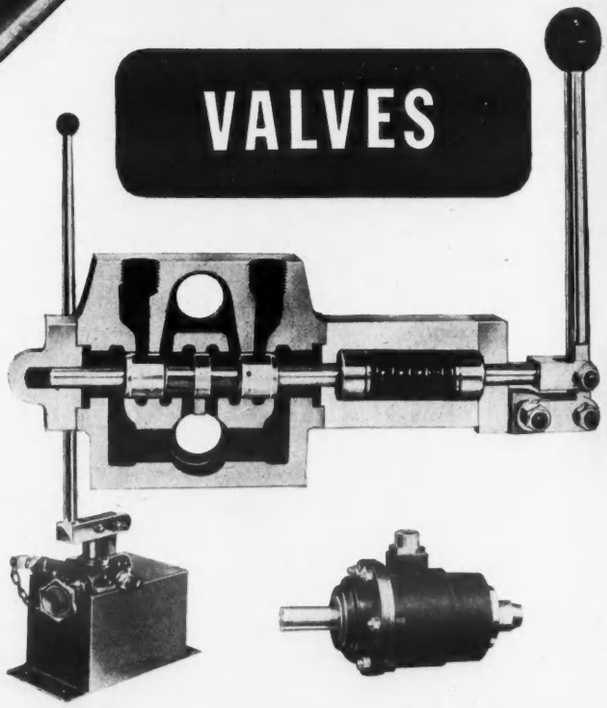

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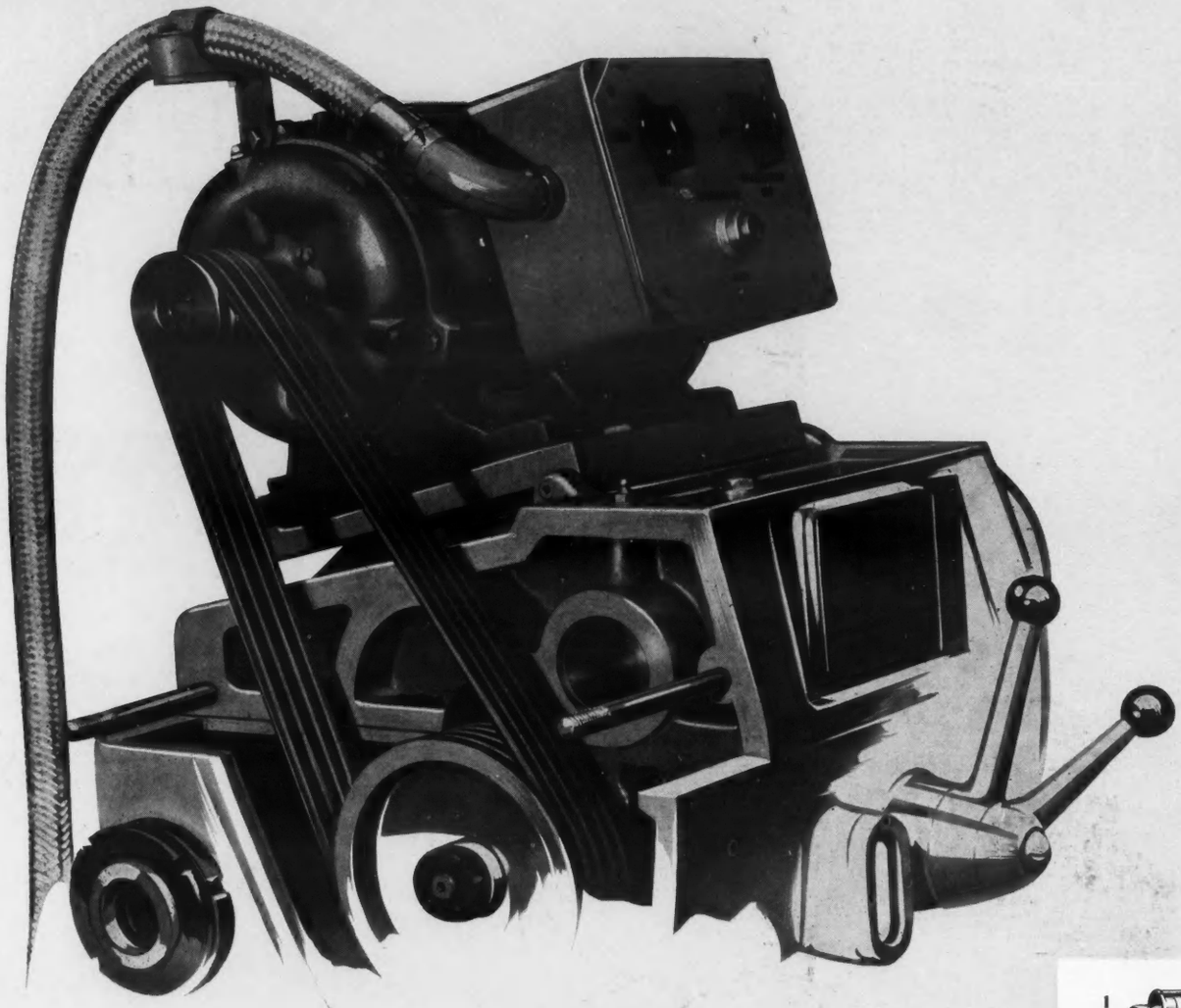

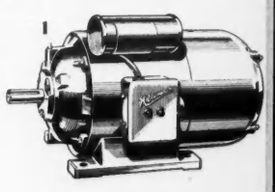

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New NEMA Dimensions.
1/2-60 h.p. (List No. 302)

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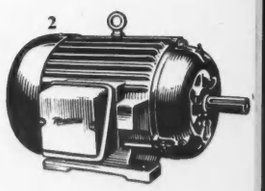

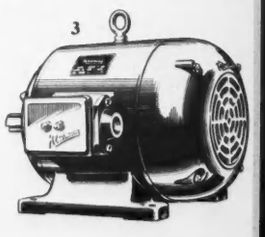

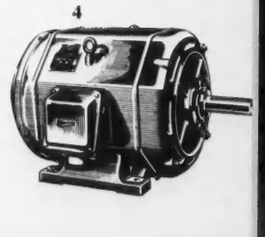

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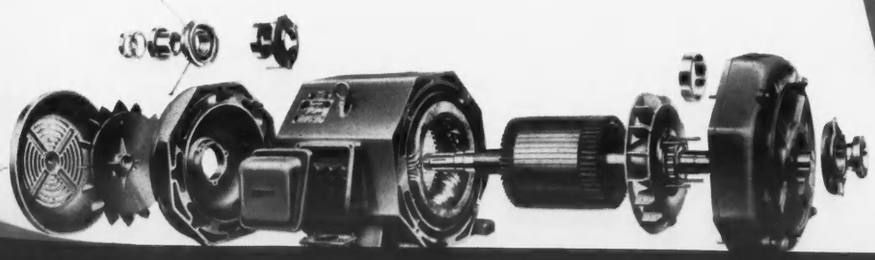
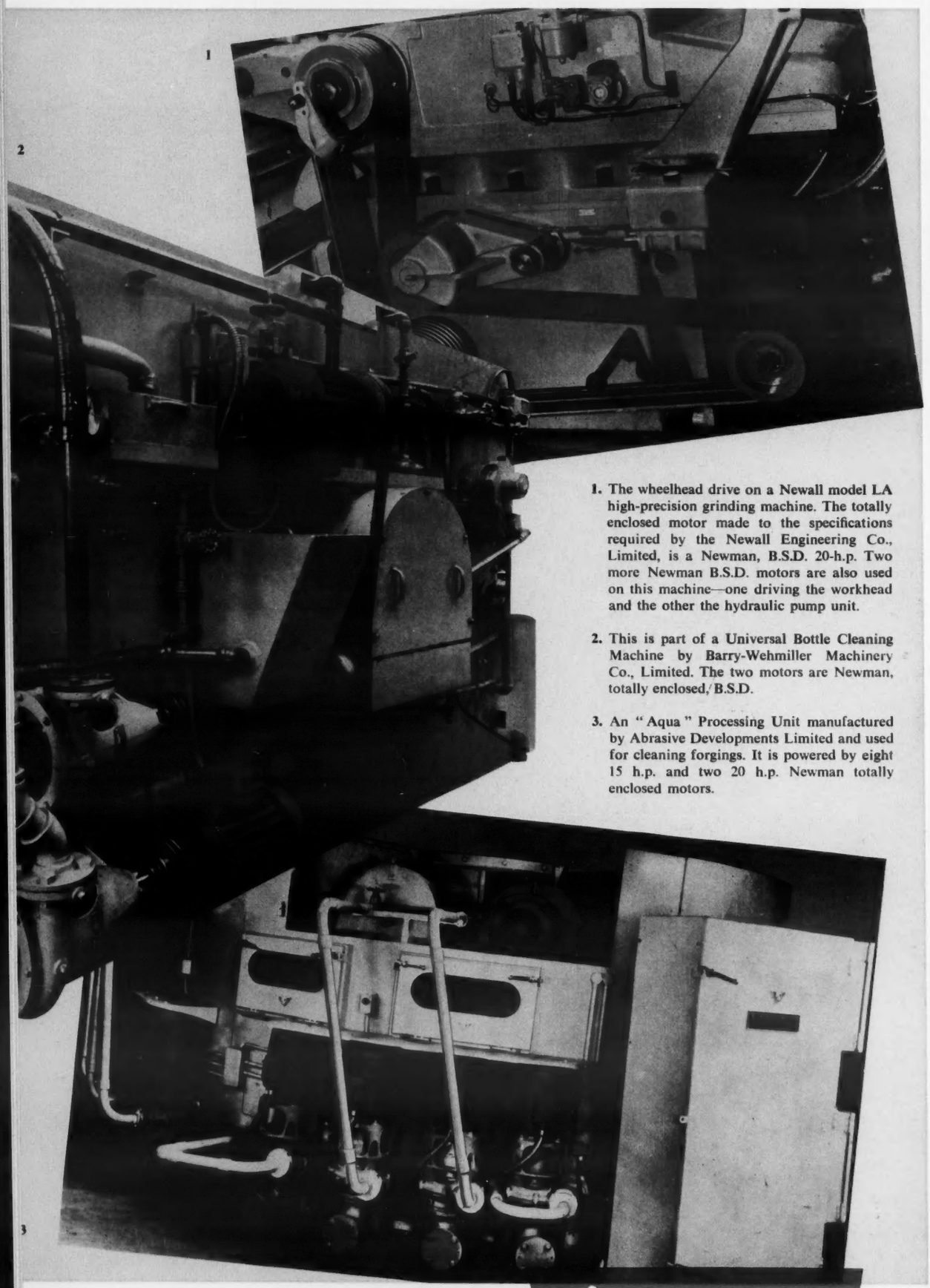


Totally enclosed motors at work



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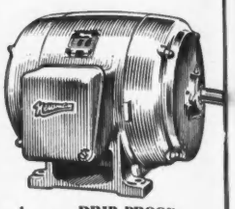

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British Standards.
1/2-175 h.p. (List No. 101)
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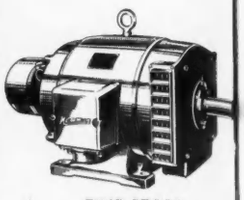
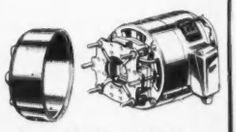
1/2-150 h.p. (List No. 102)



2. **DRIP-PROOF SLIP RING MOTORS**
British Standards 5-600 h.p. (List No. 201)
American Standards 5-600 h.p. (List No. 202)



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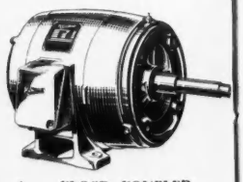

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5. **VERTICAL HOLLOW & SOLID SHAFT DRIP-PROOF PUMP MOTORS**
British or American Standards.
NEMA Dimensions.
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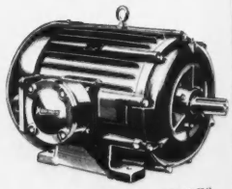

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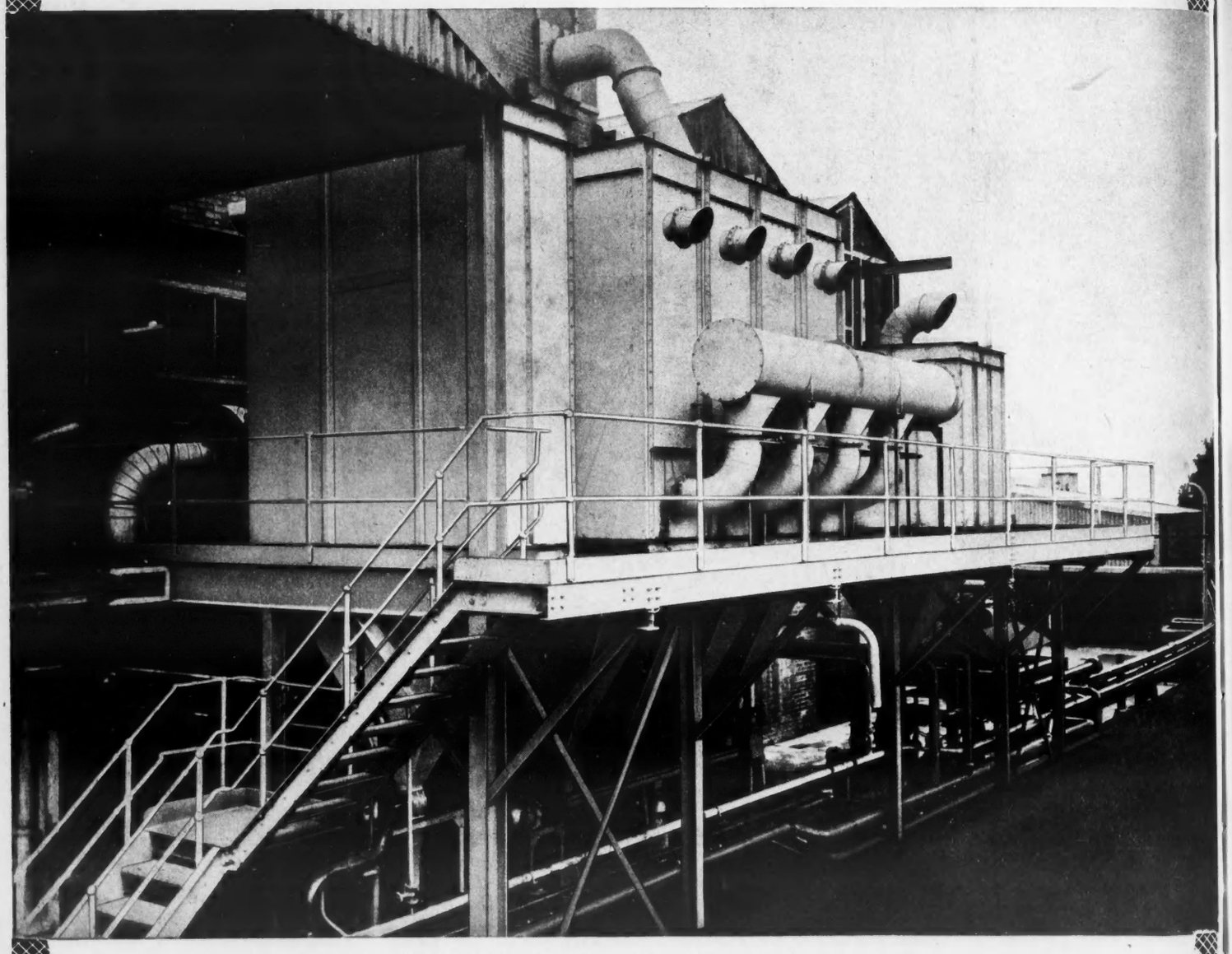

On the plant recently installed by Simon Handling Engineers, Ltd., for Imperial Chemical Industries, Ltd., Clitheroe, Tilghman automatic bag filters were chosen to remove and contain the very fine oxide powders from various mixing, pelletising and process handling points, etc.

The installation is shown in the photograph above. The collector in the centre is a 4-compartment model 126in. automatic bag filter. This handles the exhaust volume continuously and does not require shutting down for removal of accumulated dust from the filter tubes. The other two collectors are semi-automatic plants in which the filter tubes are automatically cleaned each time the exhaust fan is shut down.

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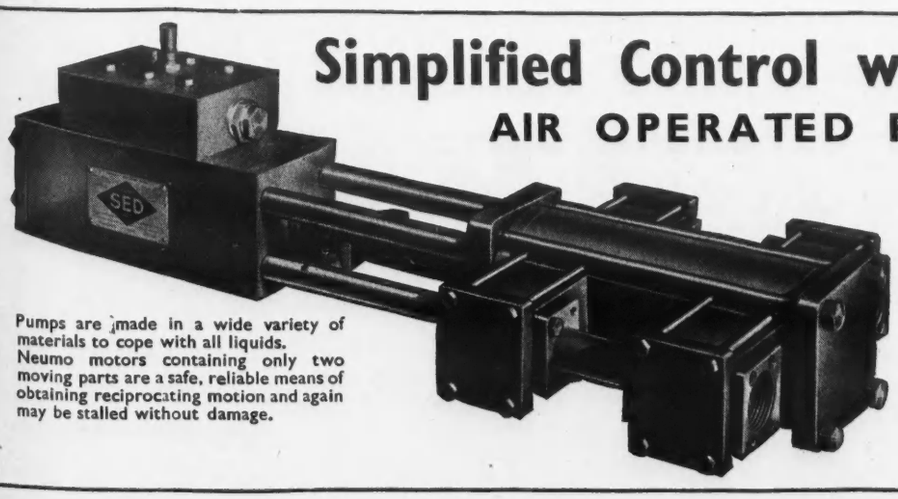

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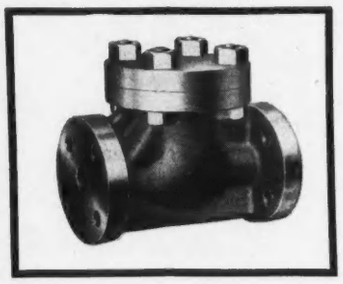

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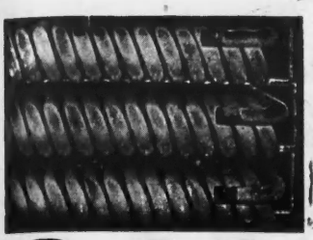

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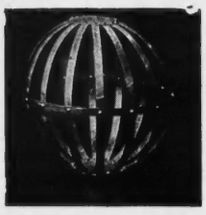

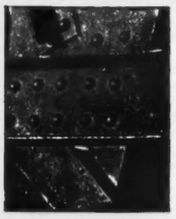

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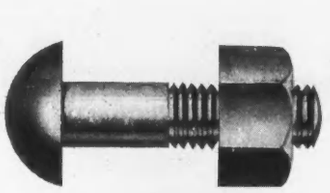

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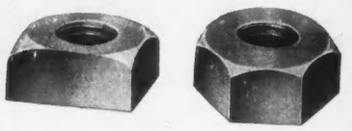
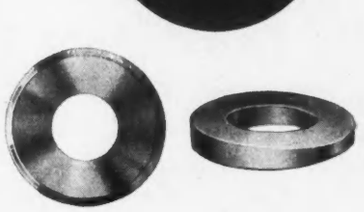
nuts





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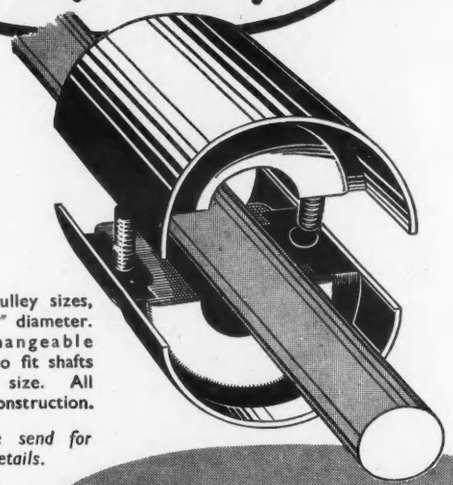

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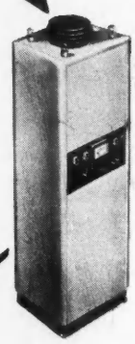

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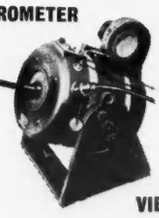

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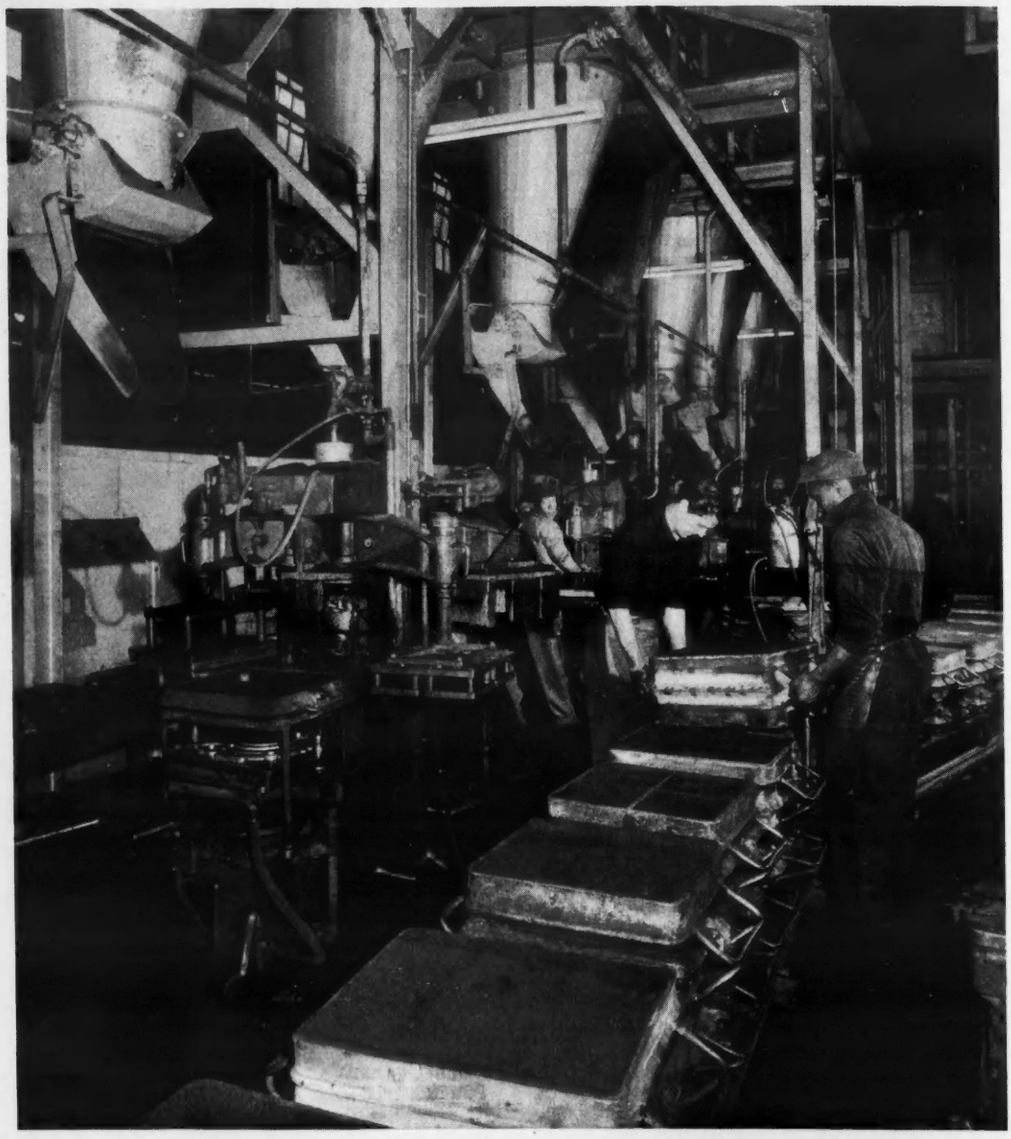

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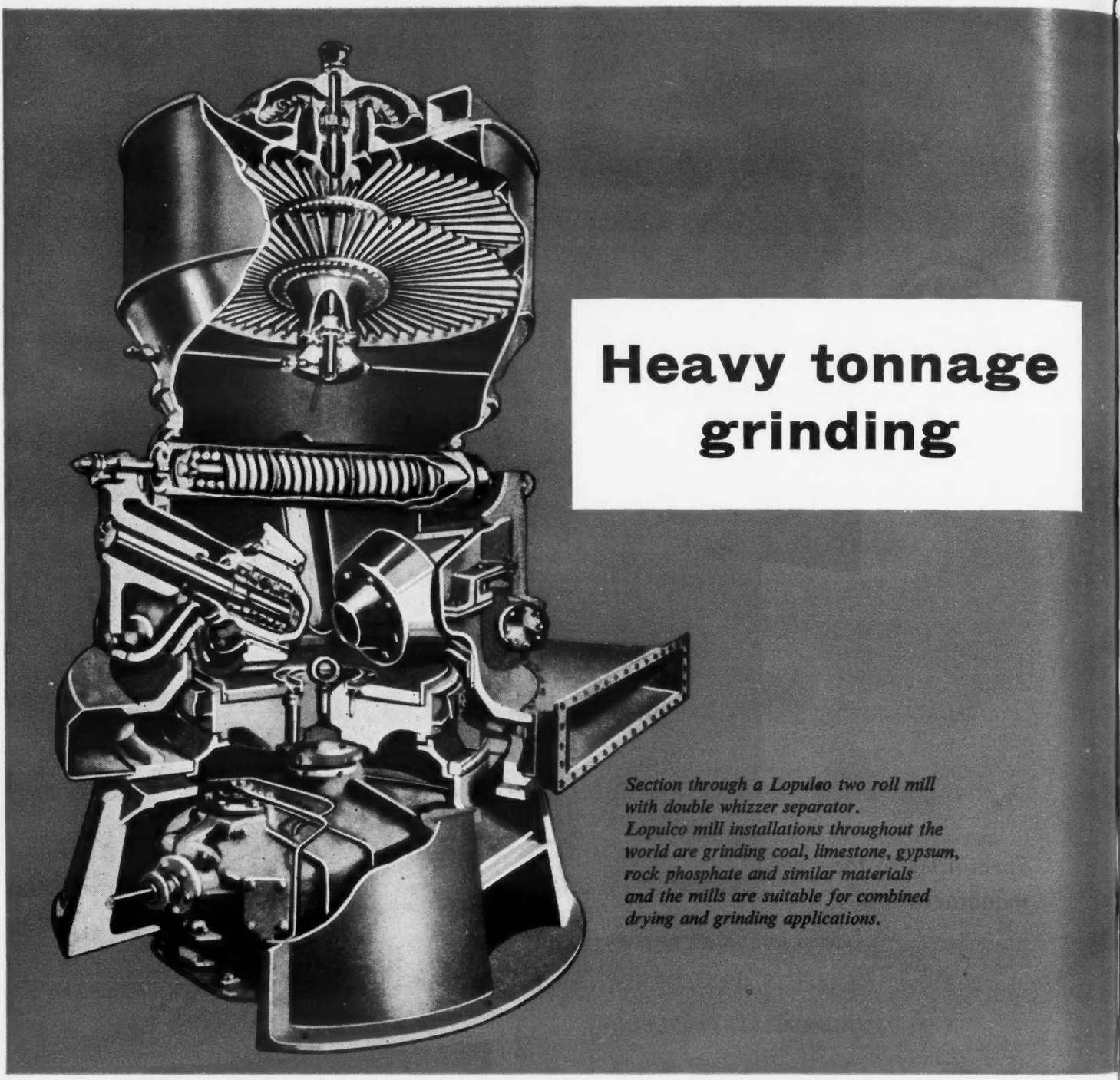

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For the finish turning of crankpins

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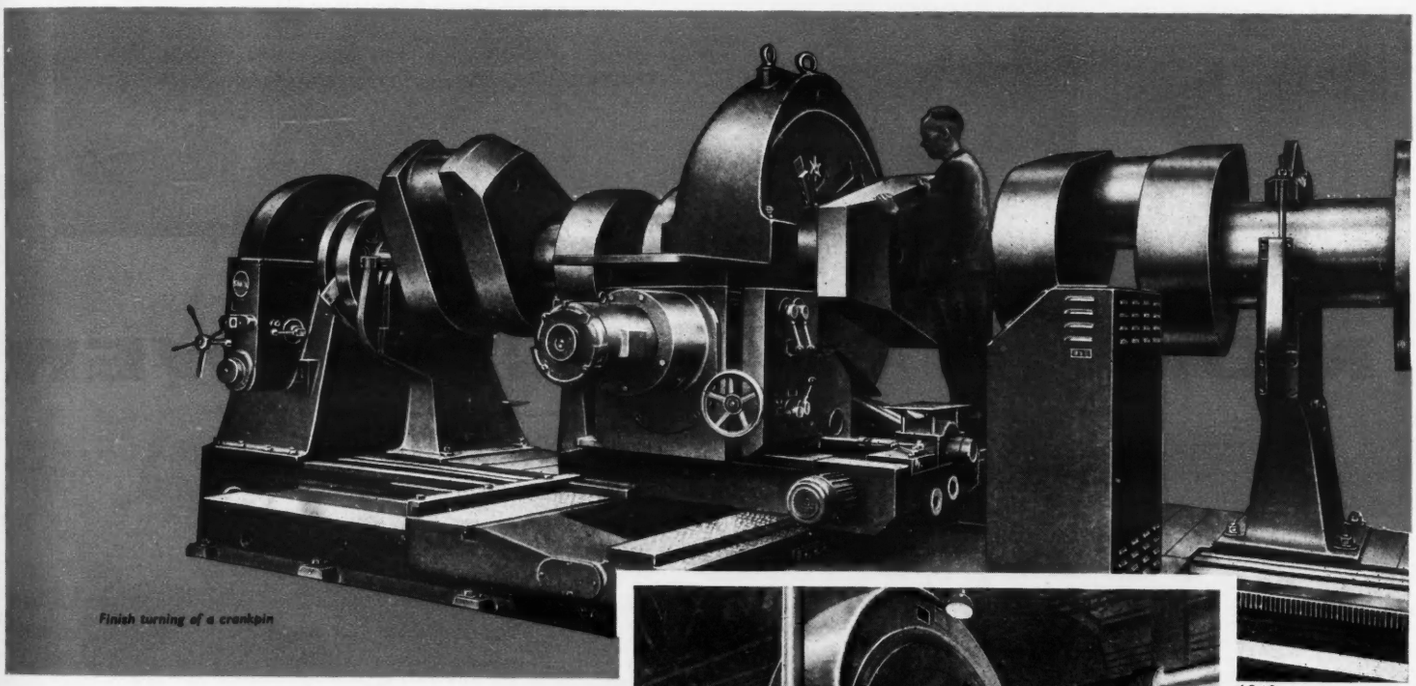
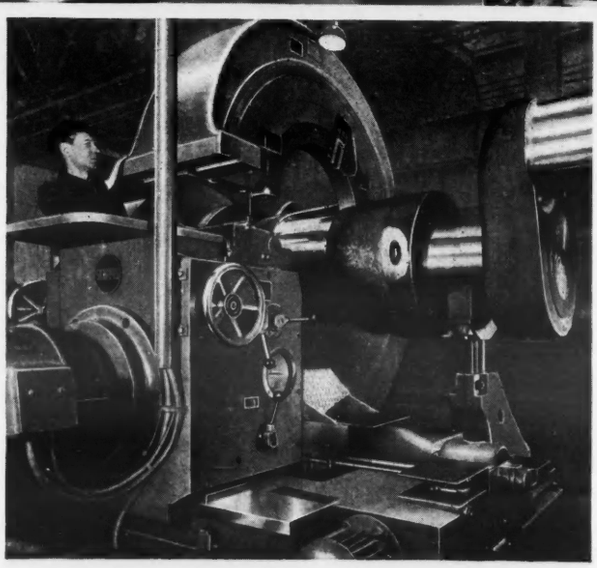


Finish turning of a crankpin

6240



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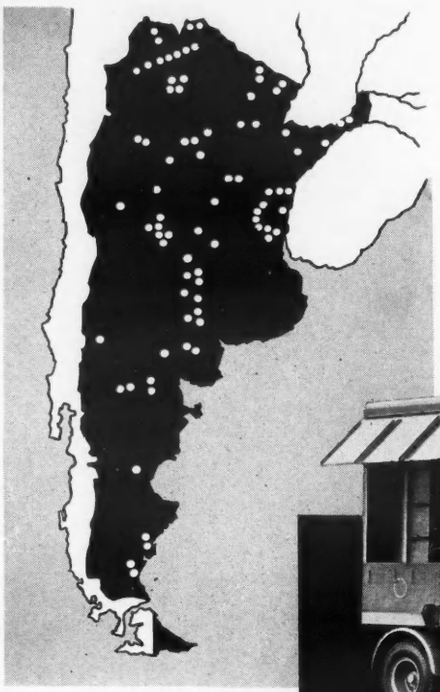

Map showing approximate locations of National generating sets in Argentina.

One of the four 500 kW transportable generating sets.

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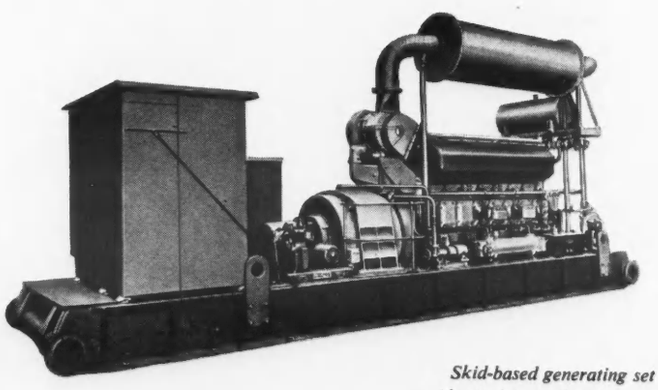

Skid-based generating set identical to trailer-mounted model to promote uniformity of operation and output.

A total of 115 National diesel generating sets aggregating over 25,000 kW are operating in Argentina, including eighty-three 110 kW and eleven 500 kW sets with standard engine baseplates.

Four further 500 kW transportable generating sets by National are now in Argentina to supplement the sixteen similar sets delivered during 1959. These trailer-mounted units are interchangeable with skid-based sets, to give standby or emergency power supply to scattered townships in the interior. Each set comprises a National R Series turbo-charged eight-cylinder engine developing 864 b.h.p. at 750 r.p.m., direct coupled to a Brush alternator complete with exciter, voltage regulator, switch-gear, etc.

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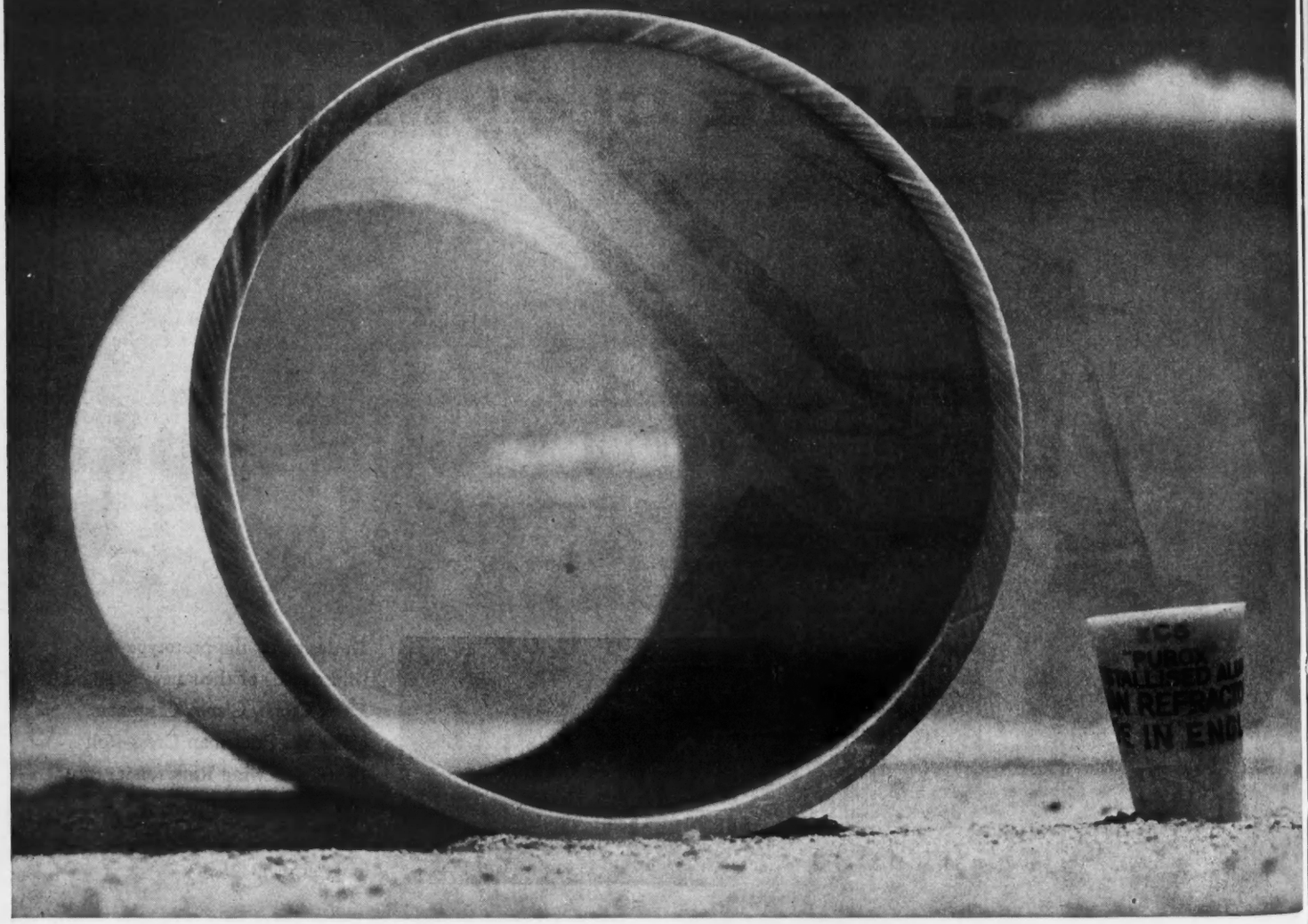

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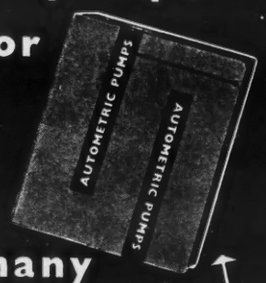

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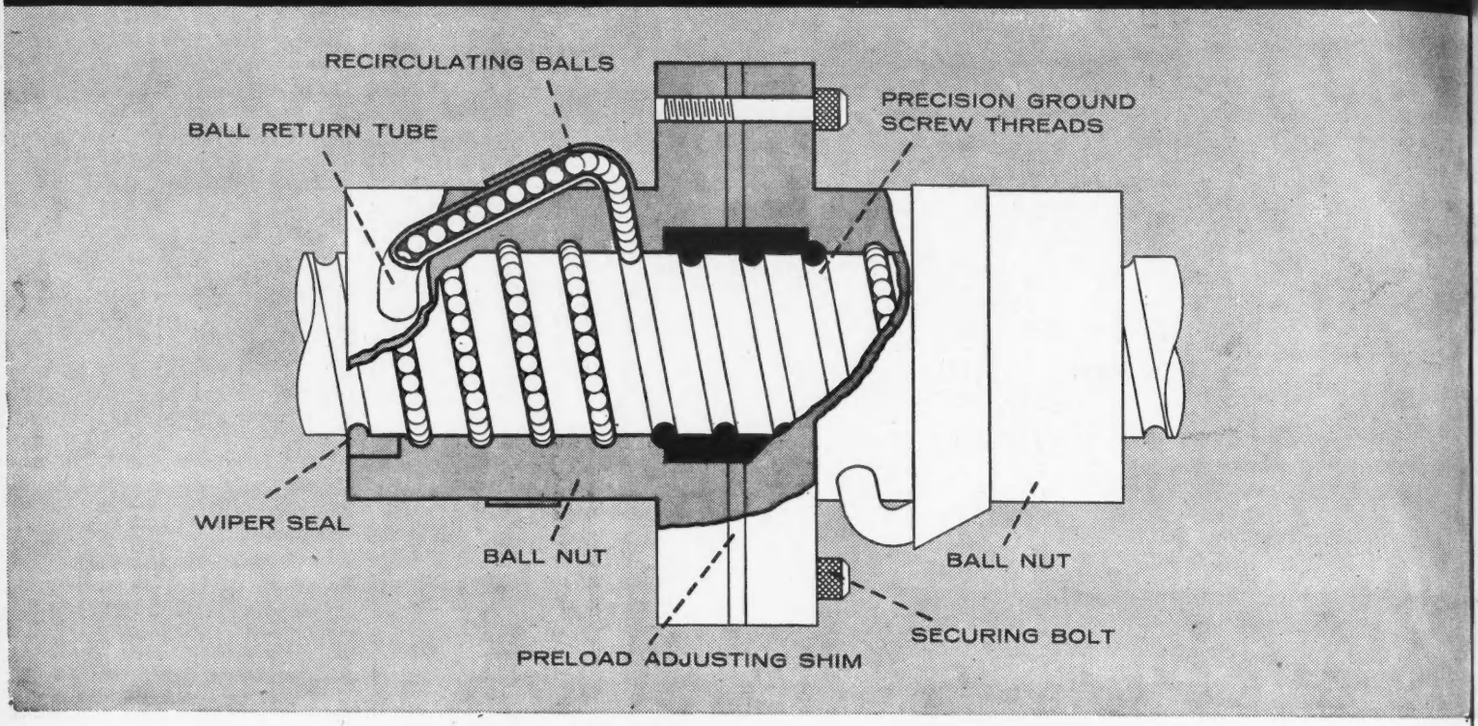

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Basic design application analysis

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Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

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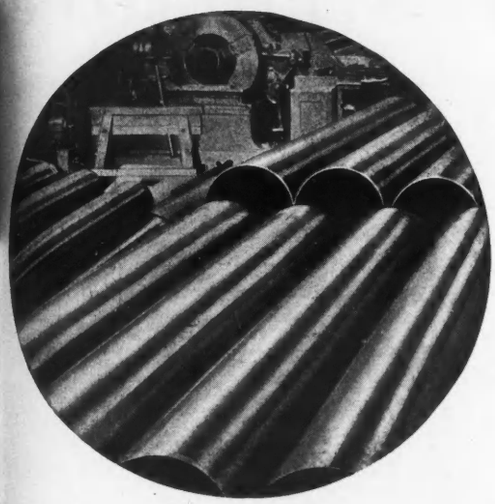

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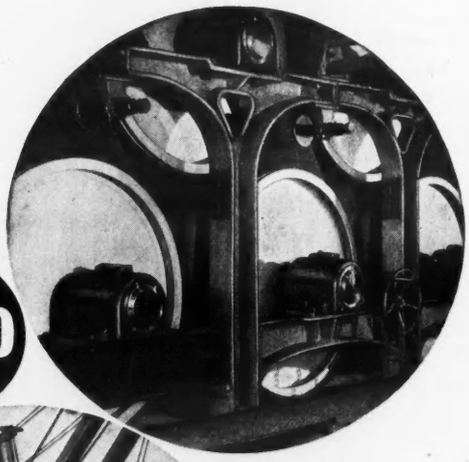

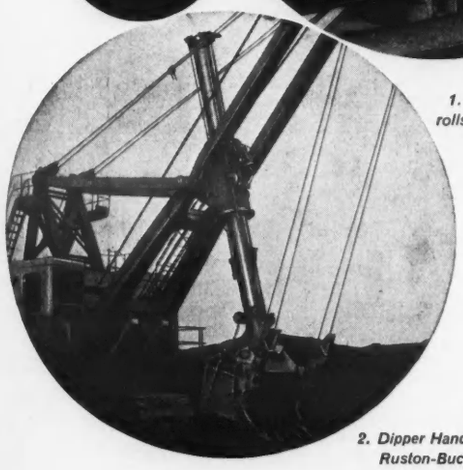

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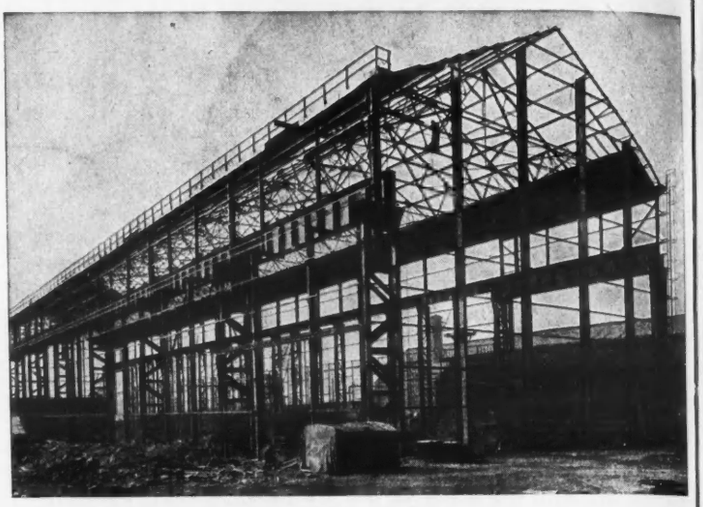

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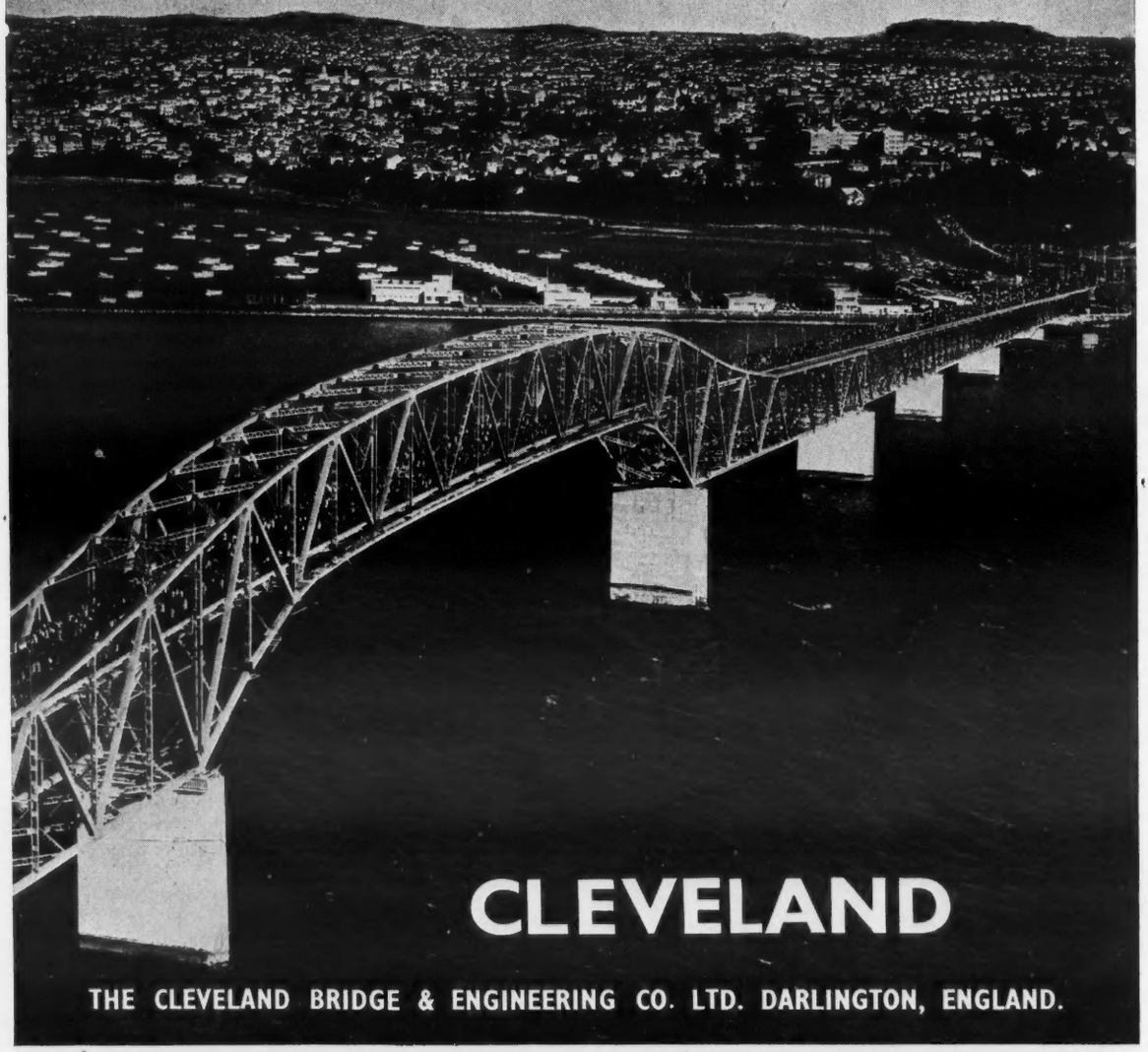

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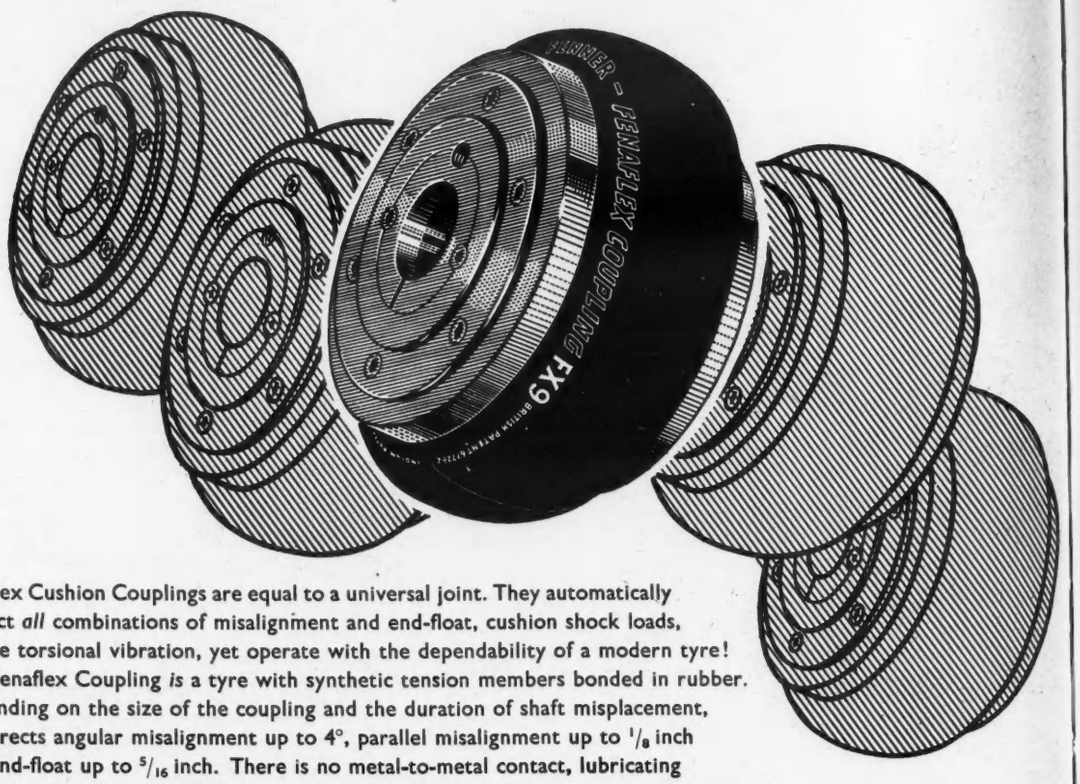

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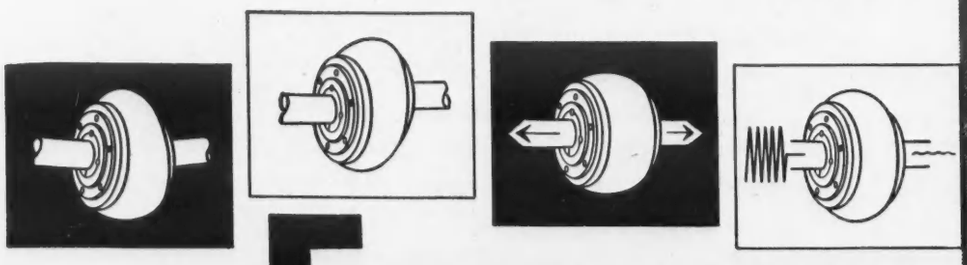

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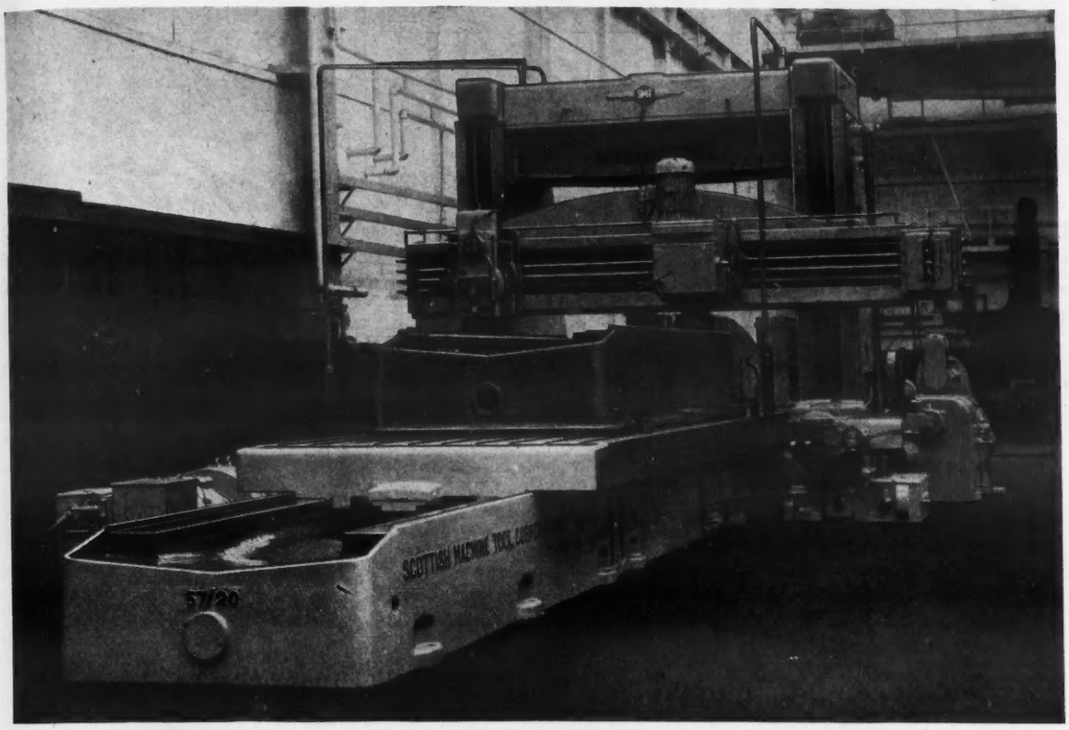

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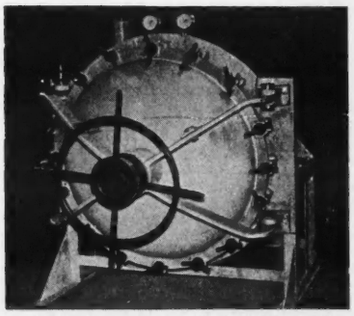

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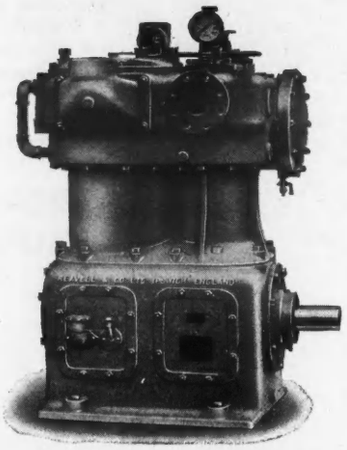

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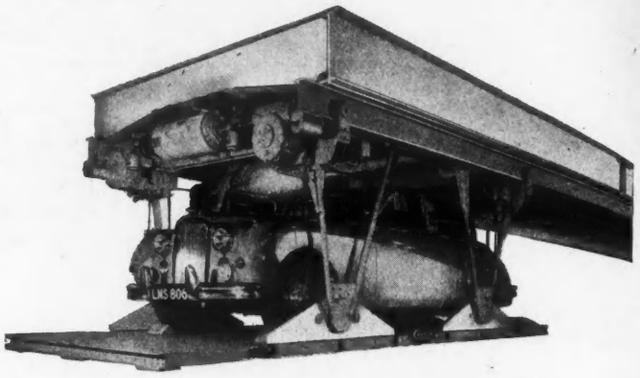

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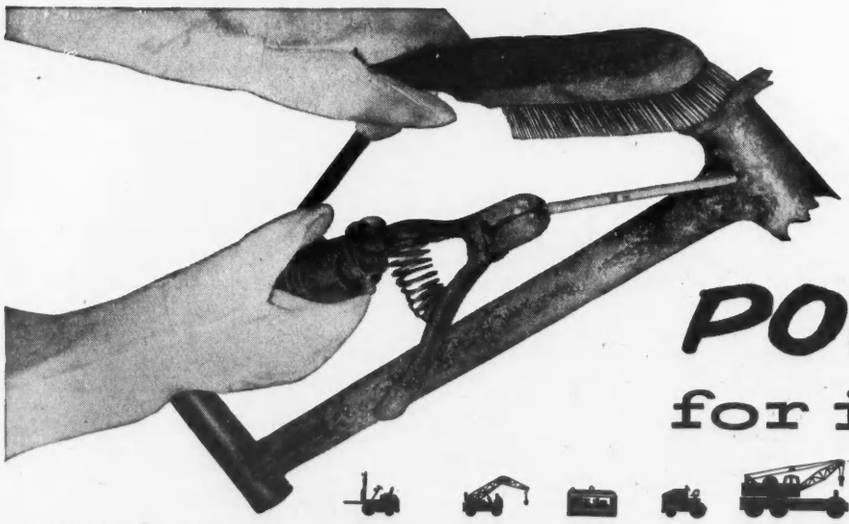

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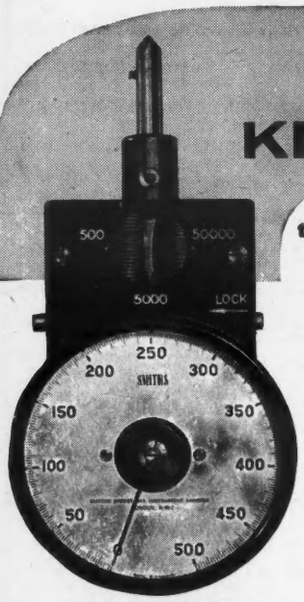

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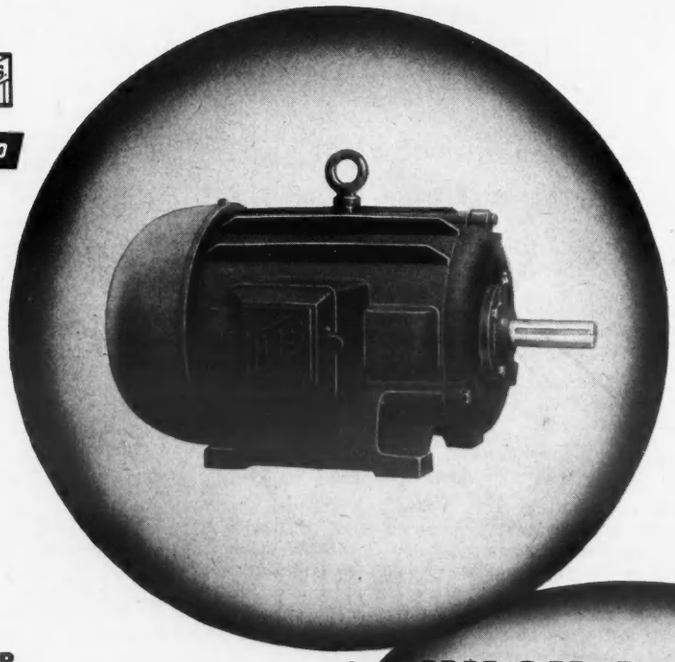

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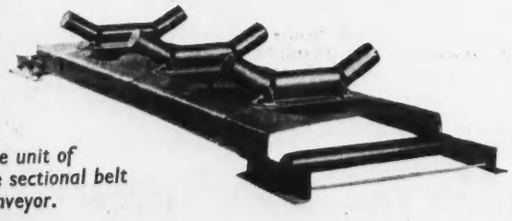

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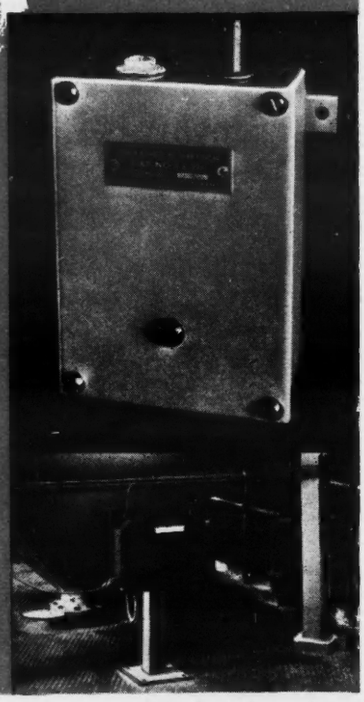

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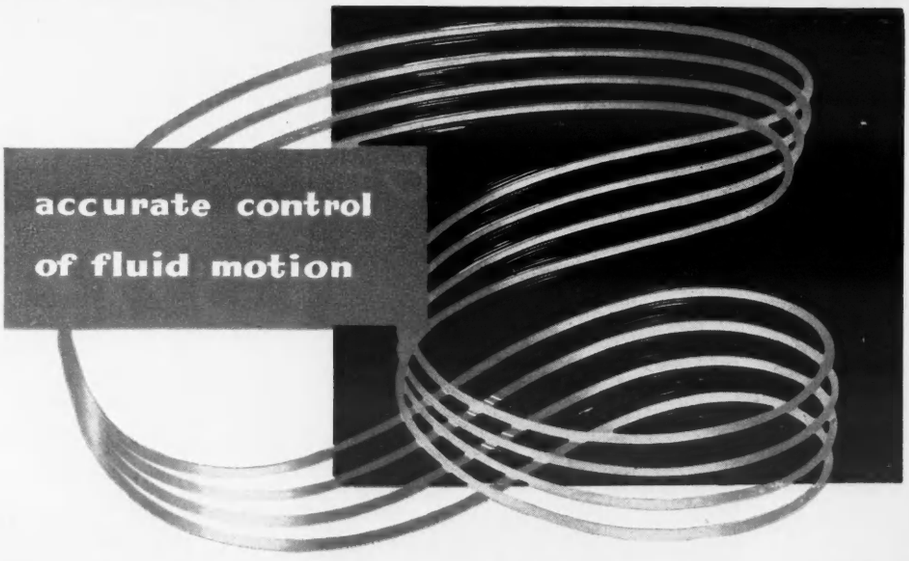

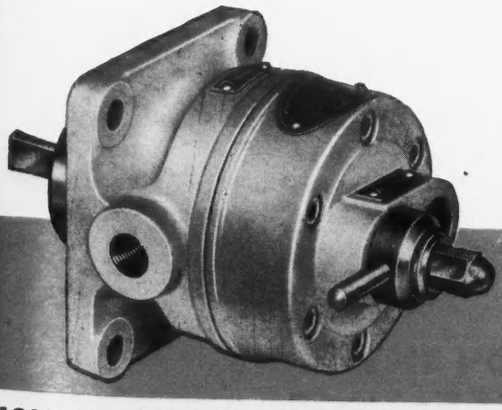

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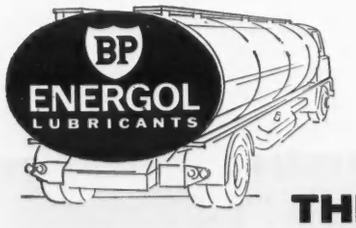

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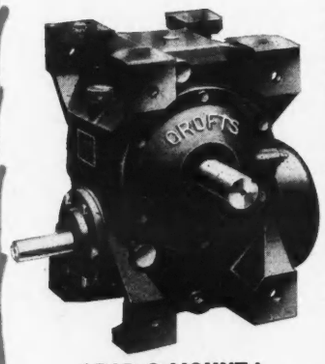

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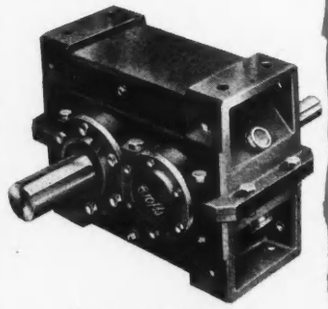

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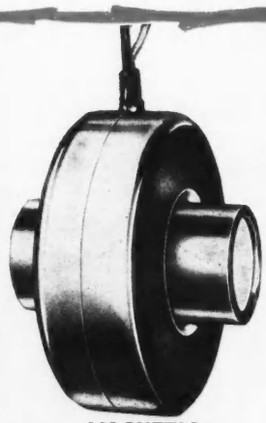

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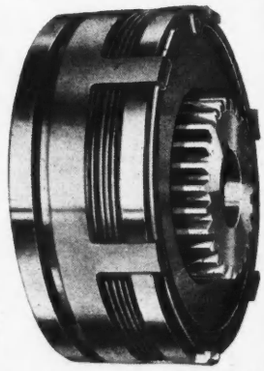

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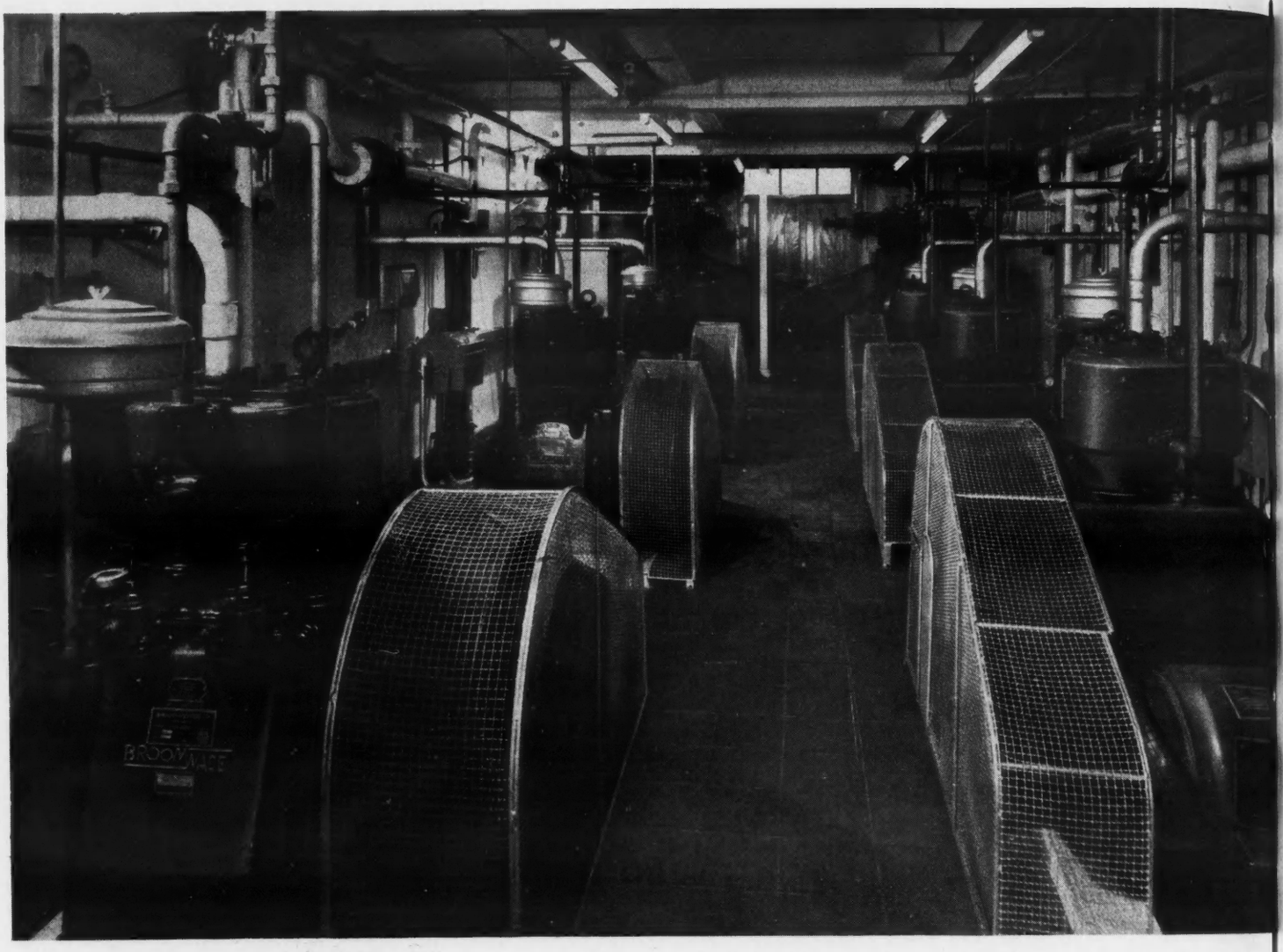

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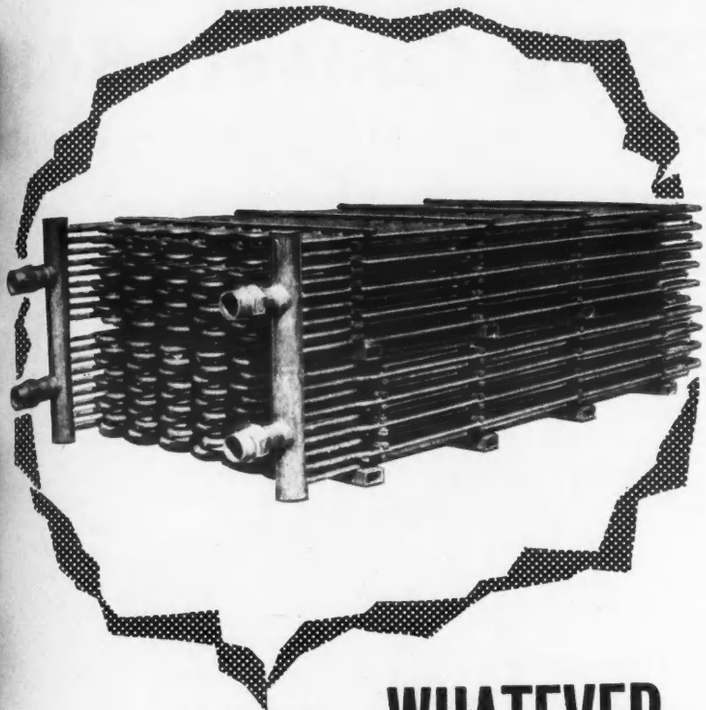

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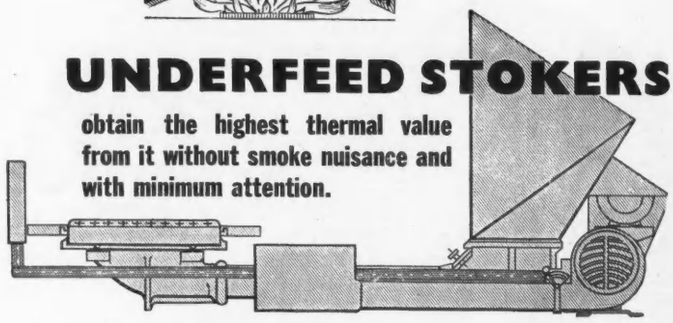

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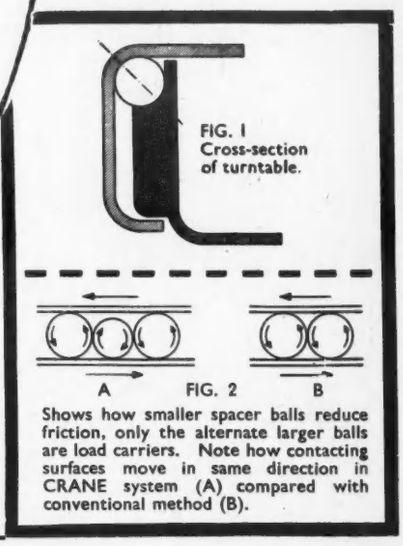

FIG. 1
Cross-section of turntable.

A FIG. 2 B

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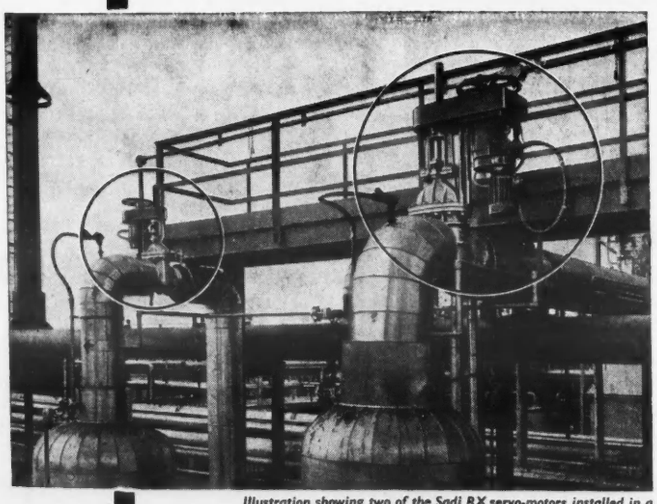

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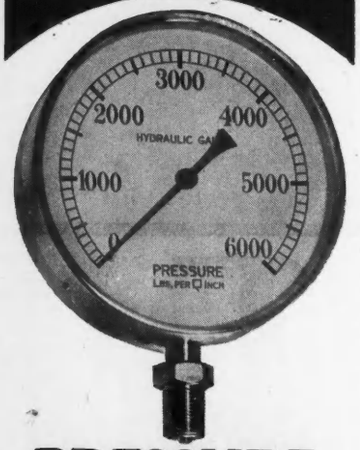

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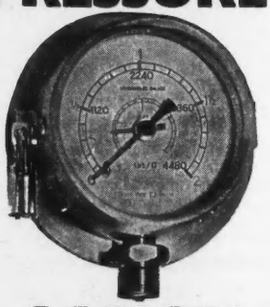

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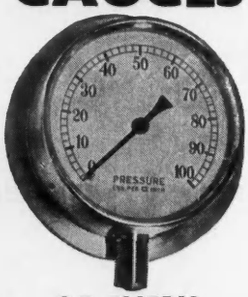

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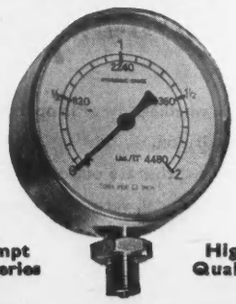

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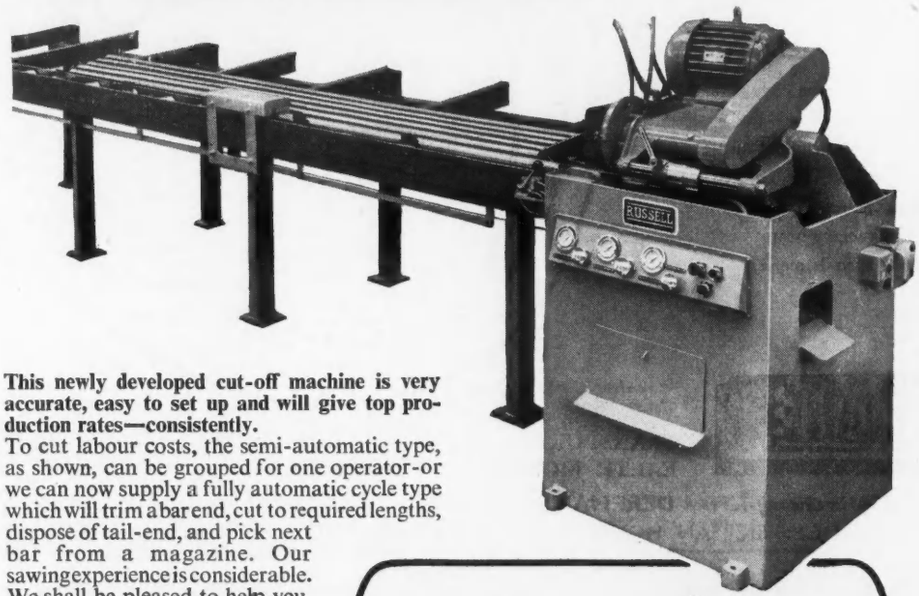

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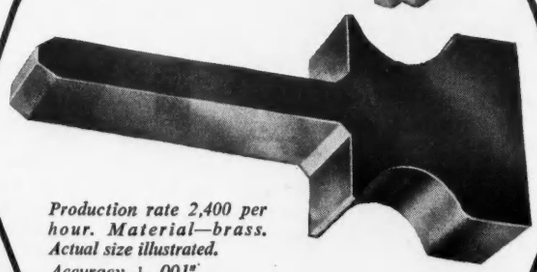

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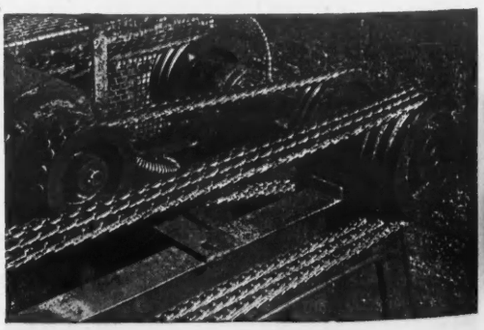

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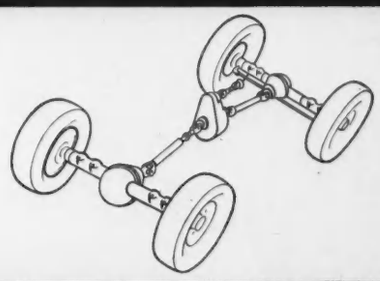

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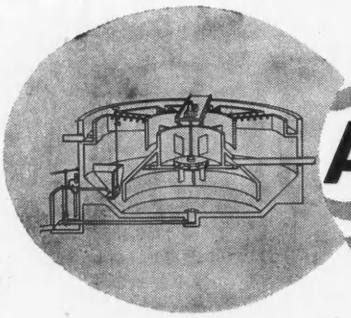

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THE ENGINEER

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SECOND THOUGHTS ON DEFENCE

Since the manufacture of thermo-nuclear missiles began, nuclear scientists and others concerned in their production have been well aware that there is no defence against them. The British Government, indeed, made this clear in its Defence White Paper three years ago and this awareness has now spread not only to the statesmen but to the peoples at large of both east and west. The use of these missiles would, in fact, make of war not a continuation of policy but a decision by a whole nation to commit suicide. No one, we think, but a dictator mad with the lust for power would make such a decision and then only if he were convinced that by a surprise attack the ability of his enemy to retaliate in kind could be wholly destroyed or very greatly reduced. None-the-less, history proves that evil-minded dictators are not creatures of the imagination but a danger, however remote, which must be guarded against—a danger the United States, which regards itself as primarily responsible for preventing a major war, has very much in mind. In recent months, the Americans have realised that relative remoteness from the potential enemy is no longer an adequate safeguard. Test firings of their own rockets of intercontinental range, now in production, have proved that these missiles land, after a journey through space of 5000 miles, within a mile-and-a-half of the target. Moreover, the remarkable accuracy of the guidance system of the space satellites suggests that Soviet rockets will be equally, if not more, accurate. In a word, it is now clear that a launching site constructed 100ft underground at immense cost, affords little protection against thermo-nuclear missiles capable of penetrating deep into the ground and fitted with delayed action fuses. Deterrent bases—as frequently emphasised in this journal—must be mobile if a potential madman is to realise that no great advantage can be obtained from a surprise attack. By its abandonment of the " Blue Streak " programme, the Government shows itself to have recognised the point.

Faced with the menace of large numbers of medium-range rockets, British defence chiefs are now considering the best kind of mobile deterrent to adopt in place of the land-based " Blue Streak." Should it be air-launched or sea-launched ? The Americans, with their vast resources, are deciding on four kinds of ballistic rocket bases to supplement their bombers : railway wagons for some or all of the new solid fuel intercontinental rockets ; aircraft ; submarines ; and, more recently, as now confirmed by the U.S. Chief of Naval Operations, surface ships. The air-launched rocket is not of immediate interest, as the " Skybolt "—which it is called—is still in the early stages of design and will require five years to develop. Meanwhile, the air-launched guided stand-off power bomb—the American " Hound Dog " can be launched 500 miles from the target—provides an effective deterrent pending the successful outcome of measures now being developed to deflect such a missile from its guided course. The British authorities seem to favour either a ballistic rocket of the " Skybolt " type launched from aircraft, or a rocket of " Polaris " type launched from submarines. A decision —whether the air-launched or sea-launched missile is the more suitable for Britain's requirements—cannot long be delayed in view of the length of time required to build a large nuclear-powered rocket-firing submarine. A sound decision cannot, however, be made until the nation knows what the Navy is meant to do—in addition to its obvious task of helping to quench a " brush-fire " overseas. To-day, apart from the few aircraft carriers and still fewer cruisers available to deal with these brush-fire campaigns, the Navy has some eighty fast anti-submarine frigates or converted frigates and is building or about to build two hunter-killer submarines. What for ? Not, surely, for an H-bomb war which this small, concentrated country of ours could endure only for a very short time ? To admit that a thermo-nuclear war is probable is to rule out—except for the naval enthusiast—any requirement for the Royal Navy or Merchant Fleet.

We make no apology for returning to this subject again and again since the success of the new defence measures to be settled within the next two years depends on the nation realising it. It may well be argued that another Korean campaign—which was only made possible by fortuitous circumstances—or another Suez is unlikely. But there has been no change in human nature and if these " brush-fire " campaigns are likely, quite a serious war developing from them, fought with conventional weapons mainly at sea, appears by no means improbable. If, therefore, a seaborne deterrent is decided on—either instead of or to supplement an air-launched rocket—let the nation be consistent and have some regard to its financial resources. A 5000–6000-ton submarine armed with sixteen " Polaris " missiles is at present costing the Americans £38,000,000 and is unfitted for any other task than to act as a deterrent. Surface warships of cruiser type are also very costly. But in the not improbable war envisaged above they would be essential to provide protection for carriers and to deal with armed raiders. Their cost would be little more and their ability to carry out their cruiser function little less, if they were partly armed with the " Polaris " rocket and thus provided Britain's share of the deterrent.

THE STATUS OF TRAFFIC ENGINEERING

Speaking from the Opposition front bench on the occasion of the traffic engineering debate in the House of Commons, in March, Mr. R. J. Mellish announced that his careful researches into the subject had convinced him that the title " traffic engineer " is a misnomer. It will not involve any drastic reopening of the matter if the status of traffic engineering in this country is brought under further discussion ; for—as we understand the present position—finality on it is still a long way off. The Institution of Civil Engineers debated the subject at length in March, 1959 (as is reported in its *Proceedings*, July, 1959, Volume 13, pages 418 to 434), and in due course set up its Traffic Engineering Study Group to provide a national forum

for the subject ; and meanwhile the Institution of Highway Engineers has started examining candidates and awarding diplomas in the subject. But these valuable developments do not mean that traffic engineering is irrevocably established as civil engineering, let alone as a mere "sub-division of highway engineering and a second degree of specialisation," as Mr. J. L. Paisley chose to describe it during that Civils' debate. We believe that the entire subject, name and all, could usefully go back into the melting pot (though no doubt the name has come to stay), for it is not only in Parliament that doubts have arisen over the way in which British traffic engineering seems to be shaping—as an enclave, within an enclosure.

In this matter we would like to consider principles alone, but there is one item of expediency that, owing to Britain's tardiness in facing traffic problems, must be accorded weight. It concerns the shortage of traffic engineers. At a time when every county, city and town needs them, there are, we understand, fewer than a hundred in the whole country ! Furthermore, there is no visible surplus of highway engineers ; and no excess of embryo highway engineers in the three to five-year pipeline of the training machinery ; and, finally, no evidence that any high proportion of either category will opt to specialise in traffic in preference to construction. Under these circumstances, surely it would be unrealistic to limit the practice of traffic engineering to highway engineers : Britain might be condemned in that way to remain woefully deficient in the art—or science.

Is it an art or a science ? We ourselves have normally been careful to leave the question open, naming it both, because we could never regard it or any engineering subject solely as a science. One reason is that, in our estimation, traffic engineering, more so than certain other forms of engineering, has at least as much to do with people as with things. We have, indeed, been concerned to observe that the discussions of the Civils' study group have had the reverse tendency—more to do with things than with people ; so that they have been, to an appreciable extent, highway engineering as much as traffic engineering discussions. We also recall being taken to task, in our own correspondence columns, after we had advocated experimentation—the trial and error technique adventurous—in traffic engineering. It was put to us that, like many other engineers, traffic engineers should make their mistakes only on paper, never on the ground. But, we reflect, one cannot put human nature on the drawing-board ; and it must be presumptuous of anyone, in any walk of life, to be confident of predicting human behaviour. Some of the more valuable conclusions of the Road Research Laboratory, for example, have been derived not from rational arguments as to how road users ought to behave but from observation in the field of the ways in which they do, in fact, behave. The notion that every move in traffic engineering can be plotted to the stage of perfection on paper beforehand, as if it were an edifice, strikes us, therefore, as probably wrong and we begin to wonder whether possibly some highway engineers may be constitutionally handicapped in their approach to traffic problems by their training. But so much needs to be discovered about traffic engineering that nothing is certain : it is not even certain that it really is engineering ! It may just be operational research into traffic behaviour ; and even if the results are applied, does that make the subject necessarily an engineering one ? For ourselves, we think it does ; but we can quite see that others may not. The only certainty seems to be that the title has become already fixed. Traffic engineering is the subject and those who practice it will henceforth be termed traffic engineers !

We think that the interests of the public, and of the calling itself, may possibly be well served by some who come to this work with fresher minds than highway engineers not specially trained to the subject may have. There is very much to be done in this line of activity, and certainly not all of it is conventional engineering. It demands, we suggest, whole-time work and thought, and is too important to be treated as a minor side line of the county, city or borough engineer's department. We would urge local Highways Committees to consider that aspect of the matter particularly, and reflect on the advisability of following the example of the Ministry of Transport, which has found it necessary to set up a traffic engineering organisation, directly under the Minister to help him shoulder his responsibilities for London.

RAILWAY CROSSOVER

About two months ago the curves representing steam-hauled and electric or diesel-hauled coaching train-miles on British Railways crossed over, and now the newer forms of traction are responsible for a little over 50 per cent of the total. This was one of the developments quoted by Mr. John Ratter, member of the British Transport Commission, at a press conference on Monday, when he gave a general review of the position now reached in the modernisation plan. The plan as a whole has also attained a turning point, being now at the stage of achievement rather than preparation and development. This autumn will see three large electrification schemes, totalling about 600 track-miles, due for completion. Two of them are suburban (Liverpool Street to Bishop's Stortford and branches, with conversion from d.c. to a.c. of the Liverpool Street–Chelmsford–Southend services ; and part of the Glasgow suburban area) but the third is the Manchester to Crewe electrification which forms the first stage in the Euston–Birmingham–Manchester–Crewe project. For main-line travellers outside Southern England, long-distance travel by electric trains is still fairly remote, for while Crewe–Liverpool is scheduled for next year, the Euston–Birmingham–Crewe section is not due until 1964. However, Mr. Ratter was able to forecast this July as the date of introducing the new Pullman diesel-electric air-conditioned trains between London, the Midlands, Manchester and Bristol, which promise to set new standards of comfort in express travel. In the South of England the Southern Region presses on with its 750V d.c. schemes under the dispensation which relieved it from the necessity of converting to a.c., and is due to complete the second phase of its Kent Coast undertaking next year. The Eastern Region, on the other hand, is having to convert its 1500V d.c. system between Liverpool Street and Chelmsford to a.c., as mentioned above, in order that a.c. may be used for the further electrification into East Anglia. Little is heard these days of the 1500V d.c. Manchester–Sheffield electrification, inaugurated with some éclat as recently as 1954, as the first British all-electric main line, but with one end in the a.c. area at Manchester, and the other, at Wath and Sheffield, only a short distance from the projected a.c. electrification of the King's Cross main line through Doncaster, its future will have to be decided before long. It might form a useful field for experiment with dual-system locomotives.

The most widespread change in travel on British Railways has been the introduction of diesel units and locomotives, and Mr. Ratter forecast that, by the end of 1961, 80 per cent of the passenger train operation on

British Railways will be by diesel or electric power. The multiple-unit diesel train programme is nearing completion, with 3600 vehicles operating now, and 4000 to be in service by the end of this year. Diesel shunting locomotives now number 1400 and the end of next year should see the end of the steam shunter. Some of the other figures quoted by Mr. Ratter, and included in a statement issued at the conference, are mentioned in an article on page 825 this week. His review also covered permanent way, signalling, and general amenities for the public on railway premises. He reaffirmed the importance attached by the British Transport Commission to the modernisation plan as a means of letting British industry show the world what it could do for railway transport. Dual-system traction equipments as suggested above for the Manchester–Sheffield line, and as have been considered in connection with extending the Southern Region electrification from Waterloo, might be of special interest in some overseas countries where electrification already exists. While the energy with which obstacles are being overcome in bringing uniformity to our previously somewhat miscellaneous electrification system is no doubt admired, there may be a desire elsewhere to find easier solutions than converting lines which are already operating satisfactorily. In concluding, Mr. Ratter found encouragement for the future in the improved traffics which had followed diesel and electric services, and he believed that the railways could offer comfort, reliability, punctuality and safety in all weathers better than other forms of transport in this crowded island.

AGRICULTURAL ENGINEERING

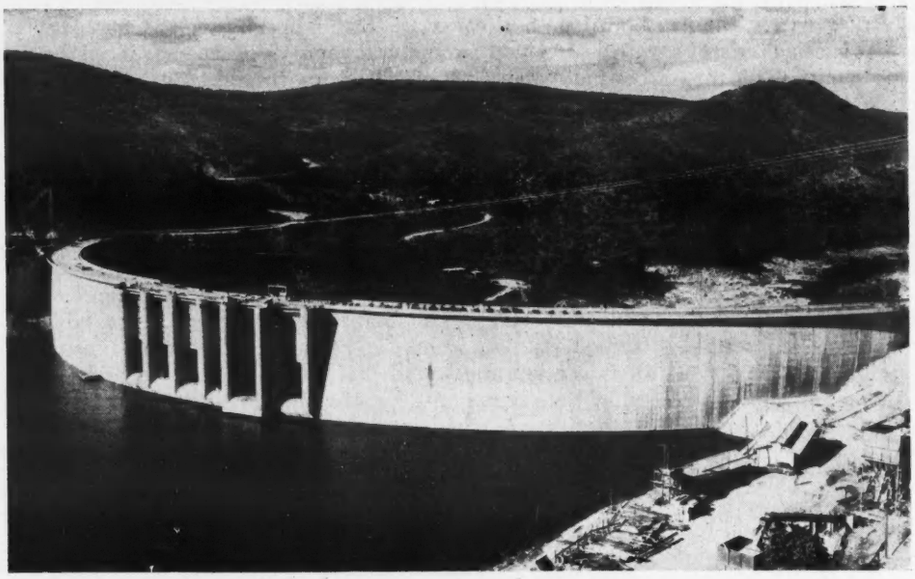
This week, we have attended two functions which have emphasised the increasing importance of agricultural engineering in this country and throughout the world. The first of them was a luncheon which followed the annual general meeting, last Monday, of the Institution of Agricultural Engineers. The Institution is now in its twenty-second year. It was formed in 1938 " to promote, encourage and co-ordinate the study, development and advancement of the profession of agricultural engineering in all its branches, and to promote the acquisition of that knowledge which constitutes the profession of agricultural engineering, being the art of directing and applying the sources of energy in Nature for the use and convenience of man in the adaptation and application of materials, machinery and mechanical methods for the best development of agriculture." There is no doubt that, in the post-war years in particular, the Institution has been untiring in its efforts to achieve the aims prescribed by its founders. The result is that to-day, both here and overseas, there is much greater awareness of the fact that agricultural engineering has advanced far beyond " the work of village plowrights and hedgeside carpenters " which was disparagingly commented upon less than a century ago. As might be expected, reflection of this kind was prominent in the after-luncheon speeches on Monday. But in those speeches, there was no hint of complacency. Five years ago, the Institution put forward suggestions for the setting up in this country of a National College of Agricultural Engineering. Those suggestions were subsequently discussed in detail with the appropriate ministries, and in collaboration with industry and educationalists. At length, in February, 1959, the Minister of Education announced that the college was to be built on a site acquired by the Bedfordshire Education Authority. A governing body has been appointed, with Sir Gilbert Flemming as chairman, but progress towards the fulfilment of this project appears to be lamentably slow. In this country's plans for higher standards of technical education, it is important to accord agricultural engineering education the place that it merits. Sir Harold Roxbee Cox, chairman of the National Council for Technological Awards, who was the principal guest at the Institution's luncheon, emphasised the tremendous need of the world's under-developed countries for agricultural machinery. A college for the training of agricultural engineers, competent to design, develop and produce the best possible machines, Sir Harold urged, ought to be made available with the " utmost expedition," especially as the activities of farm machinery manufacturers in overseas countries are in no way abating.

The second of this week's agricultural engineering functions lends further emphasis. It was an " open day " at the National Institute of Agricultural Engineering, at Silsoe, Bedfordshire. There, many hundreds of visitors were able to see the extensive research and development work which is in progress, work which is undertaken with the sole aim of increasing agricultural and horticultural efficiency. During our tour of the Institute's various departments, we learned that machinery manufacturing firms are now much more anxious than they used to be to act on the knowledge derived from the research and development work that is carried out. In addition, the Institute's machinery testing facilities are increasingly sought after. The site acquired for the proposed National College is hard by this research, development and testing centre. That, we would say, is excellent. A close association between the National Institute and a National College, offering training for an award approaching graduate standard, would certainly enhance the prestige and value of British agricultural engineering.

The Engineer—100 Years Ago (MAY 11, 1860)

" THE GAUGE OF RAILWAYS "

" Great as was the interest excited, years ago, by the gauge contest, it is well known that it was settled only upon grounds of commercial expediency. The real merits of the controversy were not determined by any exact or even practical test, in the absence of which we had merely the contradictory opinions of engineers, and the fine-spun arguments, seldom expressing more than the personal preferences, of the rival contestants generally. It is not even yet settled whether one gauge has any decided advantage over the other in respect of convenience in working or in that of speed or safety. There is one comparison, however, in which—in spite of the elaborate experiments made on the resistances of trains on the broad gauge, and the apparently low amount of these resistances—the narrow gauge has generally shown a decided superiority over the broad. This is in that of the power required, respectively, to work the two gauges. Whatever any special tests may have shown to the contrary—tests in which the circumstances of trial were probably different from those which determine the general result of practical working—the broad gauge has always employed a heavier class of rolling stock, for a given service, than has been found necessary on the narrow gauge. When we consider the admirable profile of the Great Western line, and when we compare its traffic with that of the Great Northern or the London and North-Western, we cannot overlook the disproportionately ponderous character of the rolling stock of the former line. Bringing every other element of comparison to a common standard, the engines and carriages of the broad gauge are of excessive weight, almost as much heavier than those of the narrow gauge as the gauge itself is wider."



Kariba Power Scheme

The Kariba hydro-electric scheme is to be inaugurated by Her Majesty Queen Elizabeth the Queen Mother on May 17. This scheme, in the Federation of Rhodesia and Nyasaland, is both massive in scale and simple in its overall concept. An arch dam impounds the Zambezi, and creates the head for power generation, which is utilised in power stations close to it. At present the first stage, yielding 600MW of firm power, is complete except for the installation of generating sets. The second stage will increase the total capacity of the scheme to at least 1500MW.

THE first stage of the Kariba hydro-electric scheme is to be inaugurated at a ceremony on May 17. By any standard the scheme is exceptionally noteworthy. It has been built virtually in virgin bush; the speed of its construction has been exceptional, in spite of two very severe floods whilst construction was going on; its size is exceeded by only a few other hydro-electric power schemes; its reservoir is the largest one impounded anywhere; and the actual layout of the scheme is characterised by simplicity and economy, reflecting both the exceptional possibilities offered by the site, and the advanced state, generally, of the art of the hydro-electric engineer.

Kariba is about 180 miles north-west of Salisbury, on the Zambezi river where the river forms the boundary between Northern and Southern Rhodesia. It is about 250 miles down the river from Livingstone and the Victoria Falls, and is centrally placed for the distribution of electrical power to the Copper Belt in Northern Rhodesia and industrial developments in Southern Rhodesia. The power potential of the Zambezi is such that another site between Kariba and the Falls offers the possibility of developing a head of over 500ft, and at a third site in Mozambique a larger block of power could be utilised than at the Kariba site.*

We have already emphasised the simplicity of the layout of the scheme. It comprises an arch dam about 400ft high, which serves the dual purpose of creating the head for power generation, and massive storage capacity sufficient to regulate the river almost completely. Then there will be two power stations, one built underground beneath each bank of the river, and in each case close to the dam, such that only very compact diversion works are necessary. The first stage of the scheme, which is now virtually complete, included completion of the dam and construction of the right bank power station, the capacity of which is 600MW in six similar turbo-alternator sets. Two sets are now installed and in operation in this power station, and it is planned that all six will be installed by 1962. The second stage will consist of the construction of the left bank power station. The present programme envisages the start of this stage in 1962. The installed capacity of the second station will be 900MW, with a possible extension of 300MW, so the ultimate capacity of the scheme will be between 1500MW and 1800MW. The total annual output of energy is estimated at 8500 million kWh. As may be inferred, the ultimate installation of generating sets may be influenced by the load factor of the network, for either base or peak load operation is equally convenient to achieve, but in addition, the loss from the reservoir by evaporation is known only approximately, and hence the total output of energy will not be known exactly until experience of operating the reservoir has been accumulated.

Spillage of water not utilised for power generation is also compactly catered for solely by a battery of six sluice gates set in the dam below the lowest operating level of the reservoir. There is a concrete apron on the downstream side of the dam, but the fact that tailwater levels generally give an appreciable depth of water on the downstream side and that the jets from the sluices throw the water well clear of the dam obviated the construction of elaborate anti-scour structures.

The first stage power station is laid out much in the manner that has become conventional for underground stations. Two points of interest, however, are the positioning of the transformers underground, in a separate hall, and the constructional arrangement linking the draught tube gates with the penstocks in the same shafts. There are surge chambers on the downstream side, since there is a back pressure on the turbines.

The principal data and statistics relating to the Kariba scheme are listed in Table I. Perusal of the table and of the drawings on the inset plate showing the general layout of the works, further illustrate our remarks about the magnitude and compactness of the scheme.

The difficulties of carrying out a vast and ambitious constructional scheme in virgin territory and in tropical conditions must have been immense, though we do not emphasise them in this account of the scheme, which dwells more on its technical aspects. But this situation presented other problems more exclusively of a technical nature. In particular, the installed capacity of the scheme, even in its early years, is great enough to meet the maximum demand of the area served. This has meant close attention to the programme governing the installation of generating sets, and also an economic appraisal of a range of top water levels for the reservoir. The latter is not closely limited by topography and its determination depended upon a nicety of judgment, balancing the extra cost of building higher (which is a loss in the early years of low load) against the extra power obtained at the final stage. Indeed this problem was a characteristic one, for the scheme is such as to demand very heavy initial expenditure, which must be met however much power is needed, and subsequently only comparatively modest expenditure to increase the installed capacity up to the limit.

Apart from the dam and power station, there has been considerable work in constructing new transmission lines. And a major effort—itself equivalent to a large-scale project—was needed to build access roads and a township to serve the main construction. These road and town works were started well before the main works, so as to accelerate the whole programme as much as possible. Similarly, preliminary contracts were let at the dam site for the diversion tunnel and the first stage cofferdam, well before the main contracts were let. An ingenious method of river diversion in several stages was evolved, which was a major factor in the choice of the site. A description of this early stage in the construction of Kariba dam may be found by referring to the article published in our issue of August 3, 1956, page 155. Some further progress details of the scheme were also published in our issue of December 12, 1958.

Engineering Firms at Kariba

The scheme is truly an international achievement. It is being carried out under the direction of the Federal Power Board of Rhodesia and Nyasaland, which has been set up by the Government as a generating authority. The Board's consulting engineers who are responsible for the design and supervision of construction of the Kariba scheme are Gibb, Coyne, Sogei (Kariba) (Pvt.), Ltd., for the civil engineering side, and Messrs. Merz and McLellan, for the mechanical and electrical aspects of the development. The latter firm's responsibilities have included design of the transmission system serving a wide area around the scheme. The civil engineering consultant, Messrs. Gibb, Coyne and Sogei, is a local consortium of three firms, one British, namely Sir Alexander Gibb and Partners, and two French, namely, Messrs. A. Coyne and J. Bellier, and the Société Générale des Exploitations Industrielles. The latter firm, as its name implies, specialises in planning

* The Zambezi gorge at Cahora Bassa is even more favourable than at Kariba for a high dam. A head of about 750ft and an annual output of 35×10^9kWh is feasible here.

industrial projects, especially in the field of electrical power, and the former French firm is well known for its work in the design of dams, especially arch dams. Integration of these three firms as far as the Kariba scheme is concerned, is complete, and there is no division of responsibility, each firm being jointly responsible to the Board for all the civil engineering works.

The main civil engineering contractor, who has built the dam and the underground power station, is again a locally-formed consortium, in this case of four Italian contractors. The consortium is known as Impresit Kariba (Pvt.), Ltd.; its four parent firms are Impresa Ing. Lodigiani S.p.A.; Imprese Italiane Allestero S.p.A.; Impresa Umberto Girola ; and Dott. Ing. Guiseppe Torno and C.S.p.A. The consortium's contract price for the main civil engineering works was £25,278,000 ; the contract was awarded in July, 1956. It included all the main works at the dam site as they are described in the body of this article (i.e. the first stage), except for the preliminary contract. This latter was let a year before the main one, and consisted of the river diversion tunnel, the first stage cofferdam on the left bank, and the channels excavated upstream and downstream of the first stage cofferdam. These works (as delineated in our earlier article) were carried out by the Cementation Company, Ltd.

The number of contractors engaged on the scheme is large, and other firms engaged in the principal tasks of the scheme will be named in appropriate sections of this article. We may mention here, however, that the preliminary contract carried out by the Cementation Company was worth about £1,500,000. The township—housing and associated jobs—was carried out in a very short space of time by Richard Costain, Ltd., this work alone costing about £3,500,000. The town accommodates 2000 Europeans and 8000 Africans. Access roads were another extensive task, costing about £1,500,000 altogether ; they were built by John Laing and Co. (Rhodesia), Ltd., A. G. Burton, Ltd., and the Division of Irrigation of the Southern Rhodesia Government.

The practicability of the scheme of river diversion works was verified by hydraulic model tests, which were carried out by the Société Grenobloise d'Etudes et d'Applications Hydrauliques.

Hydrology of the Kariba Site

The Zambezi rises in Northern Rhodesia and flows through Portuguese Angola in a southerly direction, then turns east across the continent and forms the boundary between Northern and Southern Rhodesia, before flowing again into Portuguese territory, Mozambique, and eventually discharging into the Indian Ocean.

The size of the catchment above Kariba is 256,000 square miles, of which there are two distinct components—196,000 square miles above Livingstone, and 60,000 square miles below Livingstone. About three-quarters of the flow comes from the former component, and is characterised by an even pattern. The latter component, however, is flashy in character. The rainfall is seasonal, giving a clearly defined yearly cycle of high and low flows.

Thus the flow at Kariba is seasonal with wide variation between the high and low water stages. The annual flood passes Kariba generally between March and May with a normal flood peak between 200,000 and 300,000 cusecs (certain leading hydrological figures are given in the table). The river falls steadily after the flood to a low flow of about 15,000 cusecs in October–November (it has, in fact, fallen as low as 8000 cusecs). The main floods are derived from run-off in Angola and Northern Rhodesia in the upper reaches of the catchment. This main flood usually passes Kariba after the rainy season in the lower catchment has fallen off.

Two exceptionally large floods occurred during construction of the dam. In March, 1957, a peak of approximately 300,000 cusecs was reached, and in March, 1958, approximately 570,000 cusecs.† The previous maximum flood on record had been 328,000 cusecs in March, 1939. The high peak in 1958 was accentuated by the simultaneous occurrence of an unusually early main flood and an unusually late and prolonged local rain. The river's mean annual flow is approximately 48,000 cusecs.

The reservoir formed by the dam will have the capacities listed in the table, and is the largest man-made reservoir, being three times larger than the Kuibyshev reservoir on the Volga, and five times larger than Lake Mead, the reservoir of Hoover dam in Colorado. Within the normal operating range between 1560ft and 1590ft above sea level 36,000,000 acre feet of storage is obtained. It will take three or four years to fill the reservoir. An additional storage range of 15ft (i.e. 19,000,000 acre feet) is for flood control.

The useful storage is sufficient to regulate the river almost completely, and with the ultimate installation of plant 83 per cent of the flow will be "firm" flow for power. Note also from the table that 9 per cent will be lost by evaporation and 8 per cent by flood spillage. The latter is based on the assumption that the reservoir level is reduced prior to the high water season and held until March 1 after which date, unless warning of an exceptional run-off has been received, the level may be allowed to rise and the flood stored. During the period of thirty years when hydrological records were kept (up to 1954) the maximum run-off in any one month was estimated at 13,300,000 acre feet, which is equivalent to a rise of about 10ft in the reservoir level, assuming no flow through the turbines or flood gates.

Evaporation loss from the reservoir is estimated to be 56in per year. This is considered to be a conservative figure, and is based on a measured figure at Livingstone, and a calculated figure at Chirundu. The mean of these two was taken, multiplied by a coefficient of 0·75 to convert it to an equivalent loss from an open water surface, and 20 per cent was added to allow for uncertainties.

One other factor which in the future might possibly increase the power available at Kariba is land development in Bechuanaland. If swamps here are reclaimed, evaporation losses may be reduced such that additional river flow results.

It was calculated that if drawdown is limited to 10 per cent of the head, the firm output of energy would vary by about 5 per cent for a 20ft change in the normal top water level, and an output of 9900 million kilowatt-hours has been calculated for a normal topwater level of 1650. As we have already explained, however, this extra output would be purchased at some cost in heightening the dam, which would not be repaid for many years, until the full output of the scheme could be utilised, and the present normal topwater level of 1590 is considered to be an optimum solution.

The dam from downstream. The discharge is from temporary compensation water outlets

† This figure is a peak discharge, measured on one day, and is not comparable with the "mean monthly" discharges listed in Table I.

KARIBA COFFERDAMS

On the RIGHT we show the first stage of construction of the dam, as it was in December, 1956. The concrete cofferdam has been built on a shelf of rock on the left bank which stood above the level of the dry weather flow. A diversion tunnel was driven under the left bank at this stage, and the points where the river flowed into it and out of it can be discerned. The tunnel was 1300ft in length, with an equivalent diameter of 39ft.

Excavation of foundations and concreting of the lower levels of the dam within the left bank cofferdam proceeded during 1956-57. In July, 1957, the left bank cofferdam was breached by explosives, and the river allowed to flow through temporary openings left in the part of the dam built within this cofferdam. Meanwhile a rock-fill cofferdam was placed downstream of the works using the constructional road bridge. This barrier confined the river to the diversion tunnel on the right and the channel on the left banks, leaving a still pool in the middle of the river. Here the main circular cofferdam was constructed. This cofferdam, as can be seen on the LEFT, consisted of two rows of steel sheet piles filled with "Colcrete," and surmounted by a thin concrete wall. The main cofferdam was completed by the end of 1957 (the illustration on the left was taken in December of that year), and work began excavating for the foundations in the river bed.

In March, 1958, there occurred the exceptionally large flood (nearly double the previous maximum) which overtopped the cofferdam causing delay and loss of the road and foot bridges, but no damage to the permanent works. The cofferdam was also breached through a hole in the rock foundation. The cofferdam was repaired and dewatered again in June, 1958, enabling work to proceed on construction of the dam. This went ahead fast and was completed to a height sufficient to enable impounding to start in December, 1958. The diversion tunnel was sealed and the temporary openings in the dam were blocked off. Thereafter the dam was completed comfortably ahead of the rising water. The illustration on the RIGHT shows the exceptional flood as it was on March 5, 1958, at about its peak.

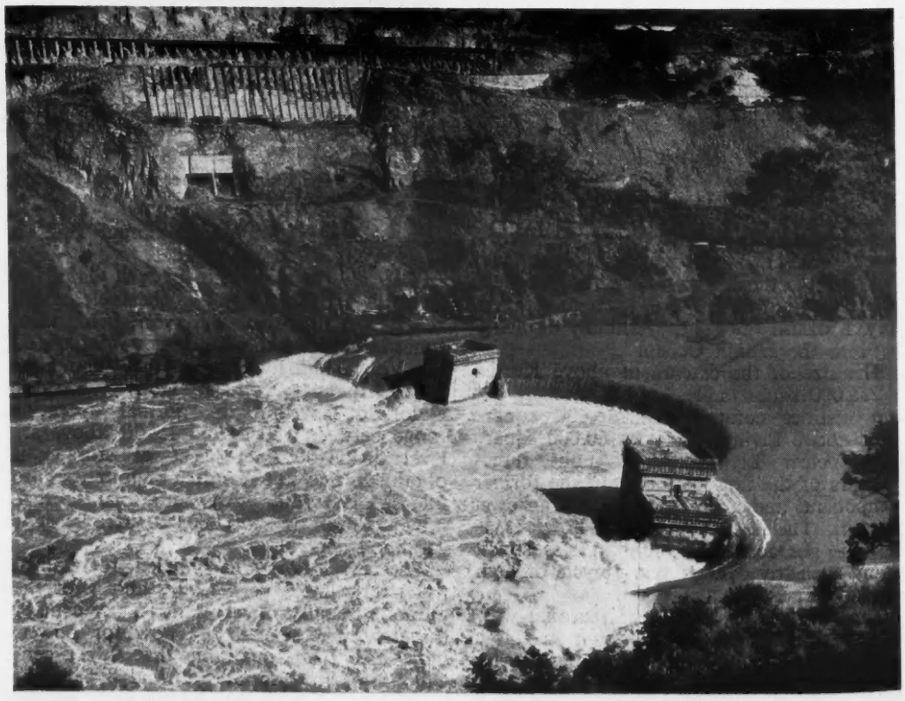


TABLE I—*Principal Data for the Kariba Scheme*

Power Generation :	
Installed capacity of right bank station, present	200MW
ultimate	600MW
Installed capacity of left bank station, ultimate	900MW to 1200MW
Ultimate mean annual power output	8500×10^6kWh
Dam :	
Maximum height of dam	425ft
Crest length	2025ft
Mean radius of arch	800ft
Total concrete volume	1,275,000 cubic yards
Spillway gates—number	Six
Spillway gates—size of each	30ft × 31ft
Reservoir :	
Reservoir capacity at 1605ft, maximum flood level	149×10^6 acre feet
Reservoir capacity at 1590ft, normal water level	130×10^6 acre feet
Normal operating range of water levels	1560–1590ft. a.s.l.
Useful storage capacity within normal range of water levels	36×10^6 acre feet
Flood storage	19×10^6 acre feet
Surface area of reservoir	2000 square miles
Length of reservoir from dam	175 miles
Hydrology :	
Catchment area	256,000 square miles
Mean river flow	51,000 cusecs
Total mean flow in one year	$37{\cdot}0 \times 10^6$ acre feet
Utilisation for power	83 per cent
Losses by spillage	8 per cent
Losses by evaporation	9 per cent
Firm flow for power	42,000 cusecs
Or, in one year	$30{\cdot}5 \times 10^6$ acre feet
Mean annual flood peak	200 to 300,000 cusecs
Mean annual low water flow	10,000 to 15,000 cusecs
Estimated probability of occurrence of mean monthly run offs :	
1 in 100	20×10^6 acre feet
1 in 1000	$27{\cdot}5 \times 10^6$ acre feet
1 in 10,000	$34{\cdot}6 \times 10^6$ acre feet
Capacity of sluice gate installation :	
At 1590 topwater level	306,000 cusecs
At 1605 topwater level	336,000 cusecs
Minimum tailwater level, 10,000 cusecs	1253 a.s.l.
Tailwater level at mean flow for power, 41,000 cusecs	1267 a.s.l.
Maximum tailwater level, 360,000 cusecs	1325 a.s.l.
Range of gross heads	352ft to 265ft

Constructional Quantities in First Stage Works

	Excavation	Concrete	Steel
	Cubic yards	Cubic yards	Tons
For dam	500,000	1,275,000	3,700
For power station, machine and transformer halls	240,000	70,000	1,250
For intakes, penstock shafts and tunnels	515,000	120,000	6,000
Totals	1,255,000	1,465,000	10,950

GEOLOGY

In the early days of reconnaissance for the Kariba project several sites were examined in Kariba Gorge, the length of which is about 14 miles. Location of the dam at the lower end of the gorge, though giving slightly greater potential head, was rejected due to the depth of riverine deposits. A site in the middle reach of the gorge, though narrow, was inaccessible and the geological report was unfavourable.

The site selected where the dam now stands is about 2 miles from the upstream end of the gorge, giving a dam whose length at road level (1606ft above sea level) is 2025ft, and height above foundations is approximately 420ft. The gorge is in a mainly gneissic mountain mass; dykes of granitic pegmatite cut across the gneiss in various directions but only play a subordinate part. The grey gneiss is by far the predominant rock, though on the right bank the gneiss is covered with quartzite above the approximate level 1450 a.s.l. The quartzite is a hard rock but very jointed and has introduced various complications. The gneiss is generally sound and monolithic ; but in some situations the rock has been weathered, for example where exposed on the left bank, to depths of over 100ft.

As far as concerned the foundations for the dam, conditions were in general terms favourable for a major arch structure. In the zone of the underground workings of the power station the gneiss varied in quality with considerable foliation and zones of altered rock were encountered. The gneiss is impervious. Another important factor in selecting this site, as we have already mentioned, was the convenience it offered for the diversion works. At low flow the river was confined to a narrow channel, thus making possible the sequence of cofferdam construction outlined opposite.

THE DAM

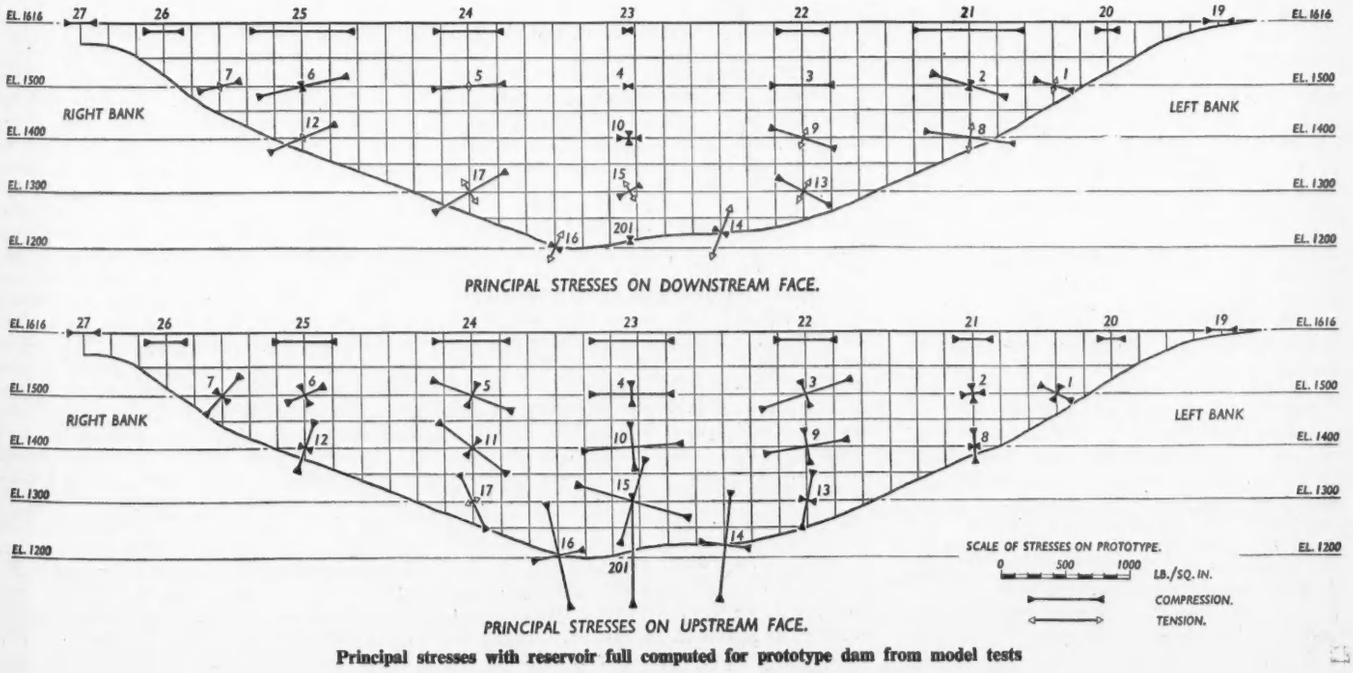
The dam is shown in the drawings on the inset plate, and in the photographs reproduced on pages 806 and 807. It is an arch dam, described as of " double curvature." Its cross section reflects the good geological conditions for the radius of the arch is quite large (the ratio height : crest length is about 1 : 5) and the thickness is the same at the crest as the toe due to the long span. Its maximum thickness is 80ft, and its height 420ft above foundations. A 40ft carriageway is carried over the crest, which is 2025ft in length. The six flood gates are the only hydraulic works built into the dam. There is no scour culvert, and the reservoir will thus never be drawn down below the 1500ft level.

Special reasons which favoured an arch dam of almost constant thickness from toe to crest were as follows : the width was a minimum at foundation level, thus reducing to a minimum the excavation in the difficult conditions at river level ; similarly, excavation of weathered rock on the flanks was minimised ; the dam has a high centre of gravity, so the quantity of concrete at lower levels was reduced, thus allowing fast progress and an early commencement of filling the reservoir ; and it was comparatively insensitive to overtopping, and direct spillage over the crest would have been possible during construction.

This design is, in fact, considered to be a " cupola " form, which results in the minimum volume of concrete for comparable concrete stresses. But bearing in mind facility in construction, the optimum curvature in the vertical direction (i.e. an upstream overhang in the lower part of the dam, and a downstream overhang at the crest) was greatly reduced.

Design was derived in the first instance from an exhaustive series of model experiments using models of 1/400 scale, made of a mixture of plaster and keiselguhr. Loads were applied to the model by either a large number of small hydraulic jacks or by the thrusts of a thin rubber bag filled with mercury. The strains were measured by a number of electrical resistance strain gauges attached to each face, and by deflection gauges having an accuracy of 1/100mm. Successive approximations from the measurements carried out on the various models led to the shape finally adopted which was then analysed using the trial load method ; the arithmetical work was carried out on a computer, the aim of this analysis being to check the results of the model tests, which, in fact, it did.

The diagram below gives details of the principal stresses in the dam under loads due to both gravity and to the full hydrostatic head of the reservoir. Temperature loading was unimportant in this case, for there is little variation in the temperatures experienced at the site. However, the constructional programme was such that the lower part of the dam was subjected to loading, as the reservoir began to fill, before the upper part was constructed, and this sequence of application of load was followed



Principal stresses with reservoir full computed for prototype dam from model tests

in the model tests. It is perhaps worth mentioning that in the case of Kariba dam, the "reservoir empty" condition of loading will never be experienced. The principal stress diagram shows clearly that tensile stresses occur in one or two places, but they are within permissible limits. The maximum compressive stress nowhere exceeds 1000 lb per square inch, but approaches this figure throughout the body of the dam. The structural tests with the models were carried out by the Société d'Equipement Industriel et de Laboratoire.

Concreting the Dam

The first skip of concrete in the foundations of Kariba dam was ceremonially placed by Lord Malvern on November 6, 1956; and the last skip was similarly despatched by Sir Roy Welensky on June 22 last. Thus 1,275,000 cubic yards of concrete was placed in thirty-one and a half months.

The batching and mixing of the concrete for the dam was carried out in two similar stations, built side by side on the left bank. Each of these two stations was designed for the installation of four 4 cubic yard mixers, but in fact one of them operated to full capacity, and only two mixers were installed in the other.

The mixers discharged into 8 cubic yard skips, which were traversed by a special vehicle to a platform beneath the cableways, of which there were three, each of 22 tons capacity. All the main concrete in the dam was placed by these three cableways, except for some on the left bank which was placed by derrick.

In general the concrete was placed in 7ft 6in lifts, in monoliths separated by radial joints at intervals of about 50ft. Cooling pipes were laid in each lift, and chilled water was circulated to limit the rise in temperature as the concrete set. A refrigeration plant with a capacity of about 10,000,000 B.Th.U. per hour was installed to cool the river water. No maximum temperature was specified during or immediately after pouring, but circulation of refrigerant was continued until the temperature inside the concrete mass dropped down to, or below, the final stable temperature of the dam which was assumed to be 77 deg. Fah.

The lifts were poured at seven-day intervals and the programme of concreting was arranged so that concreting was always at least two months ahead of the level of the rising reservoir. In the interval, cooling was completed, and the joints were grouted. For concreting the underground works, there was a smaller batching and mixing station on the right bank.

The following data for the concrete of the dam are arranged according to the brief description recommended by the International Sub-Committee on Concrete of the Congress on Large Dams: (*a*) cement content, 330 lb per cubic yard for the mass of the dam; on water face for a thickness of 10ft, 430 lb per cubic yard; (*b*) effective water/cement ratio 0·5 to 0·6; (*c*) type of cement, ordinary Portland cement in accordance with B.S.S. No. 12 mainly from the Chilanga cement works; (*d*) petrology of aggregates, crushed gneiss from a quarry on the left bank—gradings produced were 8in to 3in, 3in to 1in, 1in to ½in, ½in to $\frac{3}{16}$in.—sand was river sand from deposits near the confluence of the Sanyati river and the Zambezi; (*e*) method of compaction: immersion vibrators—weight 47 kg—poker length 24in—frequency of vibrations 8700 r.p.m.; (*f*) and (*g*) No air entraining agents were used.

During the course of the work the cement content of the hearting concrete varied between 380 lb and 300 lb per cubic yard, but the majority was 330 lb per cubic yard as referred to above. In this case, a minimum crushing strength of 3200 lb per square inch at twenty-eight days was specified. In practice an average cube strength of 4270 lb per square inch was obtained.

An hourly production of 360 cubic yards could be maintained by the two principal concrete stations serving the dam and, as would be expected, the cableways and aggregate handling plant were laid out to match this output. In the peak period the monthly production of concrete exceeded 100,000 cubic yards.

For the coarse aggregate gneiss was crushed in two stages, screened, washed and stocked in the four separate sizes. Fine aggregate—river sand—was washed and screened, and finally separated into two gradings, passing and retained on No. 25 sieve, by "Rheax" hydraulic classifiers. A large stockpile was accumulated during the early part of the contract as the sand beds were later covered by the rising reservoir. Sufficient sand has been stocked for the concrete required in the second stage power station.

Cement came from Chilanga cement works, 125 miles away in Northern Rhodesia. Storage was provided at the site in eighty silos for 24,000 short tons, and 4000 short tons of storage in sheds enabled the peak monthly usage of cement to exceed the rate of delivery.

A grout curtain was drilled to a depth of between 80ft and 200ft below foundation level and in certain zones where necessary additional blanket grouting was carried out. The joints in the dam were grouted.

Flood Gates

The six flood sluices are set in the dam with a sill level of 1498ft. Each one is 30ft high by 31ft wide and is equipped with a caterpillar gate, and there is one set of stop beams for maintenance. One sluice was designed for passing debris. The profile of the sluices and their buckets were designed by model experiments to throw the jet clear of the dam and to disperse it in a manner to cause minimum scour. Model experiments also calibrated the gates. The discharge from all six gates together at maximum water level is 336,000 cusecs.

The Power Station

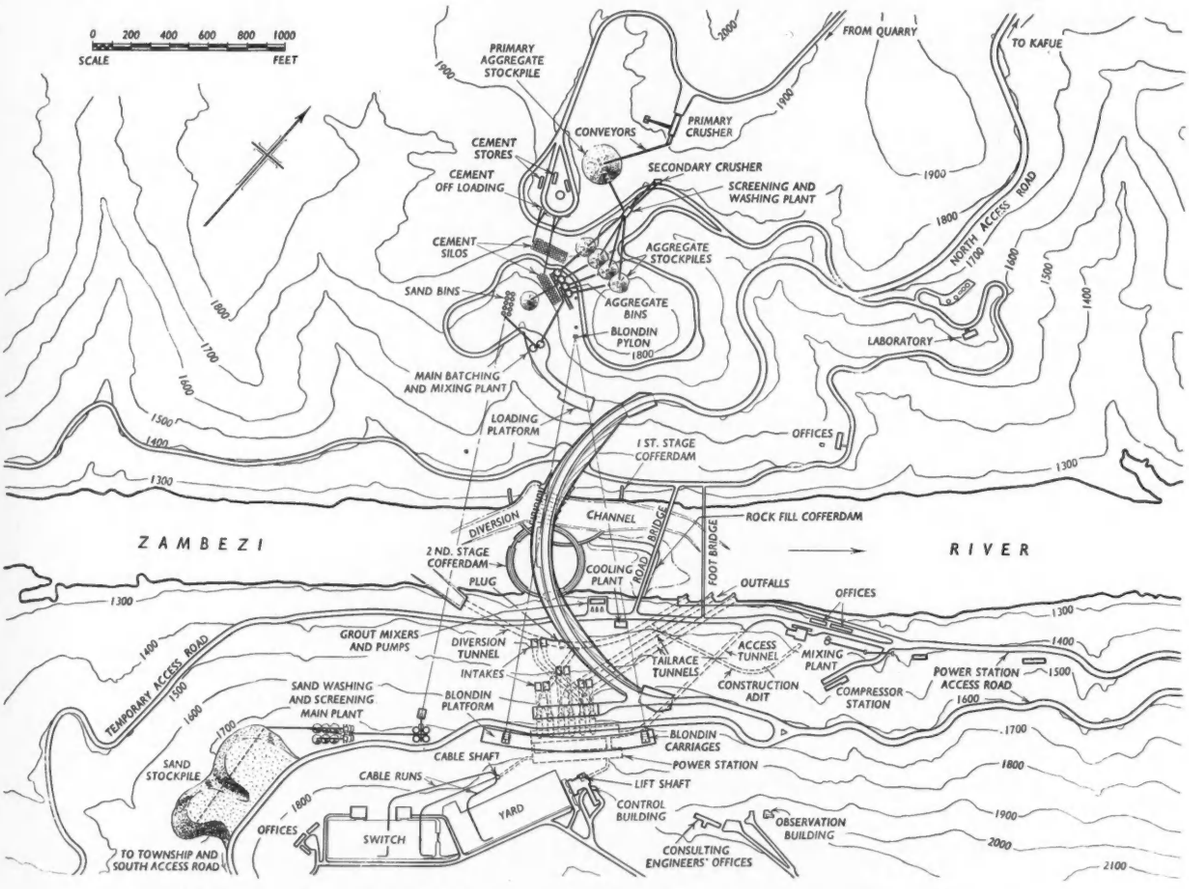
The intake works and the three tail-race tunnels—one of them a length of the original diversion tunnel used in the first stages of building the dam—are clearly shown in one of the drawings. The underground machine hall will accommodate six 100MW turbo-alternator sets. A second hall, also underground but alongside the machine hall in a separate excavation, is for the main transformer. Power at the high voltage is taken by oil-filled cables up a vertical shaft to the switching station on the surface at the top of the gorge.

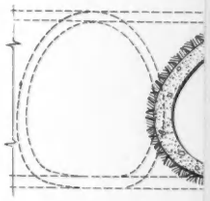
A ramped tunnel leads from the surface to the machine hall, and there are also two lifts which ascend to the control building on the surface. There are two 200-ton overhead cranes in the machine hall, heavy machinery being brought into them through the access tunnel, to a loading bay. Each turbine has a separate intake and penstock. The intakes are in the side of the gorge and each one has screens which can be raked from a gantry. The horizontal intake tunnels are each 16ft wide by 20ft high and are each controlled by a sector gate placed immediately upstream of the 90 deg. bend into the penstock. The penstocks are 20ft in diameter converging to 17ft in the steel-lined section, the steel lining being carried to the level 1364. Sector gates were chosen for the control of the turbine intakes for reasons of greater simplicity and security in operation. These gates, the steel lining of the penstocks, and the floodgates in the dam, were manufactured by Etablissements Neyrpic of Grenoble and Sociedades Reunidas de Fabricacoes Metalicas Lda of Amadora, Portugal.

Low level intakes were constructed for the first two sets at the 1370ft level so that they could be commissioned at an early date before the reservoir had filled. For the same reason sets 3 and 4 had their intakes at an intermediate level, viz. 1460ft. The intakes at 1370ft were considered too low

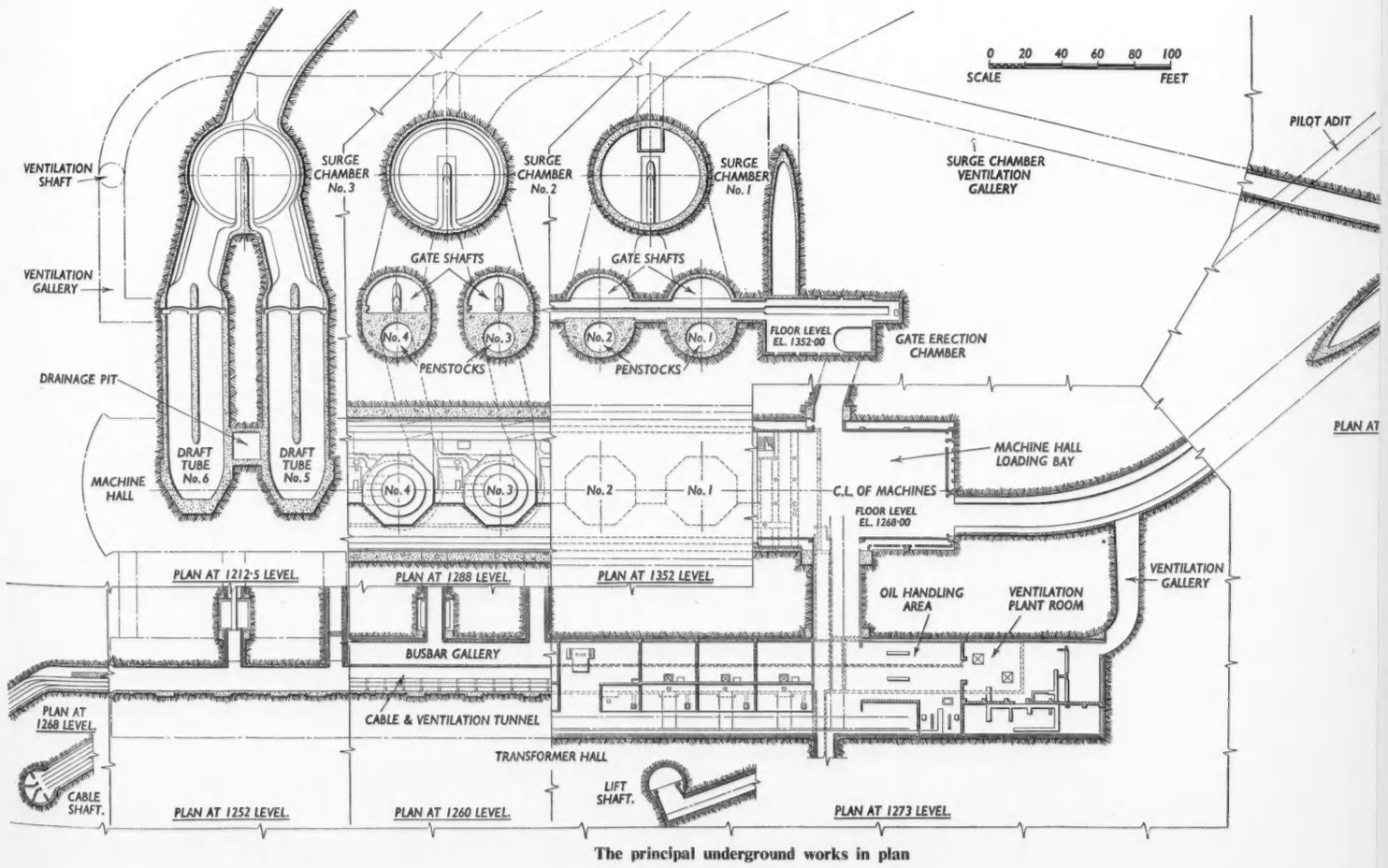
A constructional view of the main hall of the power station, showing part of a foundation block for one of the generating sets in the foreground

KARIBA



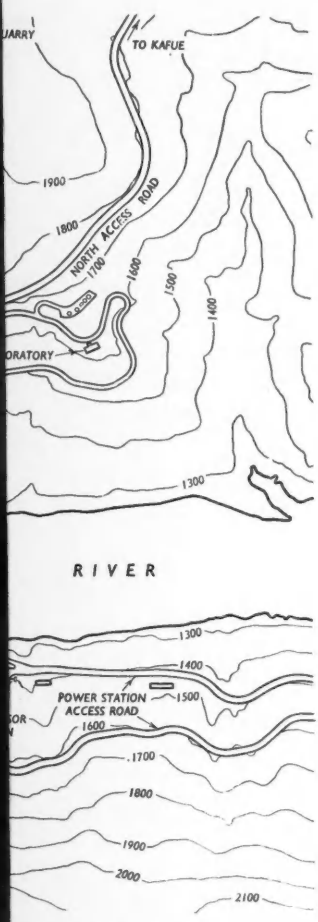


Plan of the scheme, showing the dam, the underground works, the river cofferdams and the constructional plant

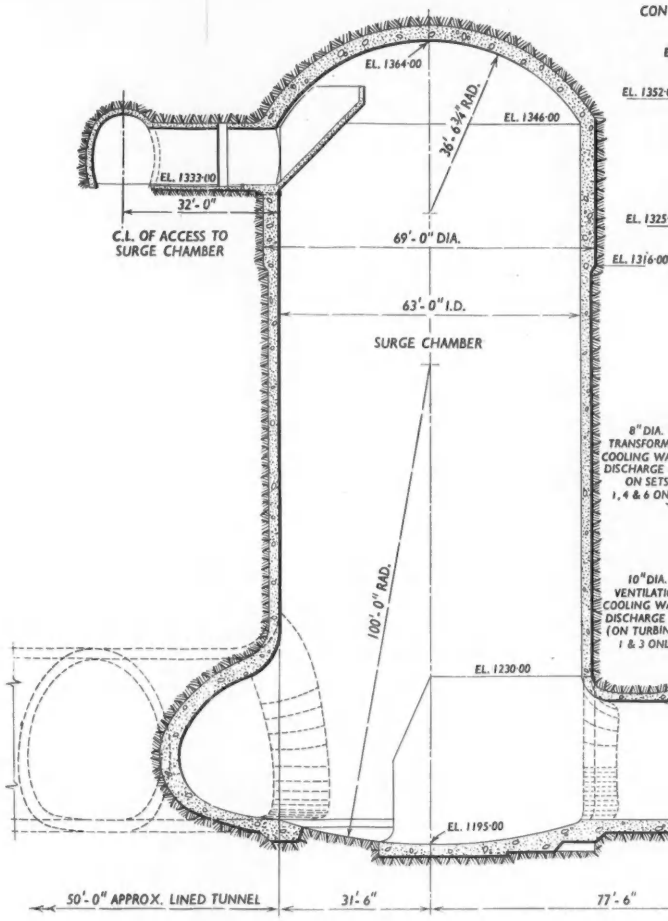


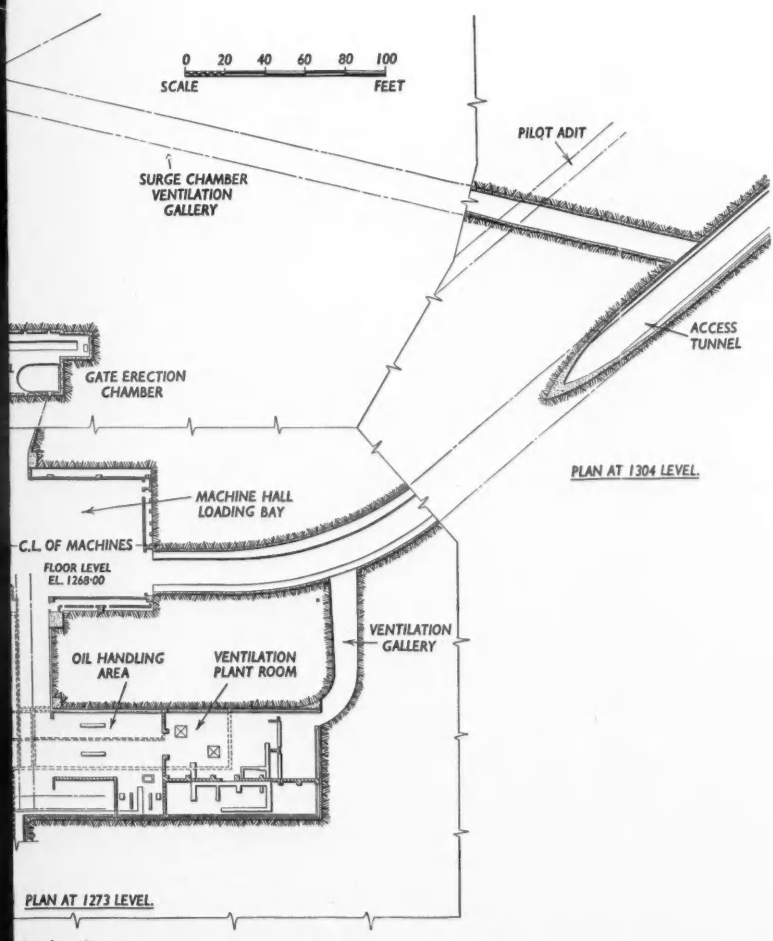
The principal underground works in plan

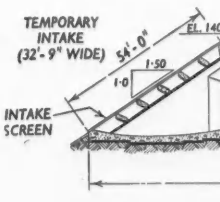
KARIBA HYDRO-ELECTR



constructional plant

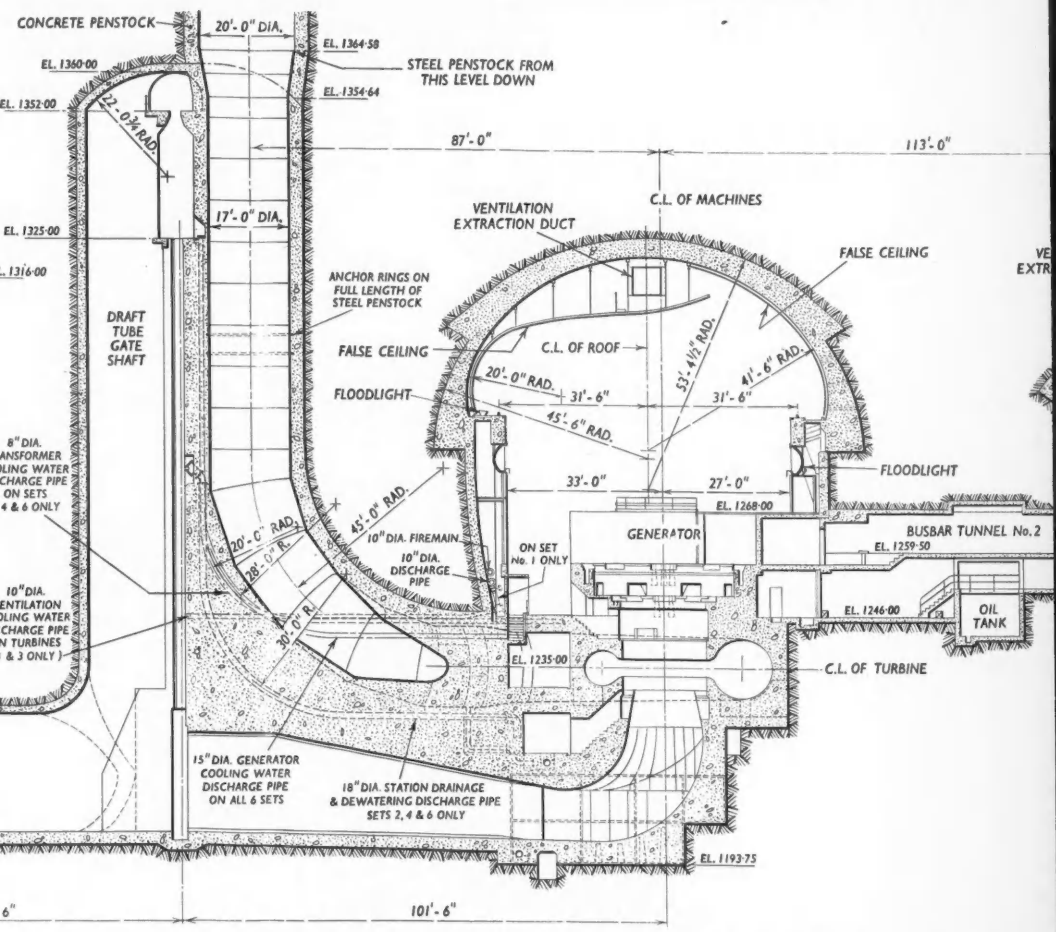




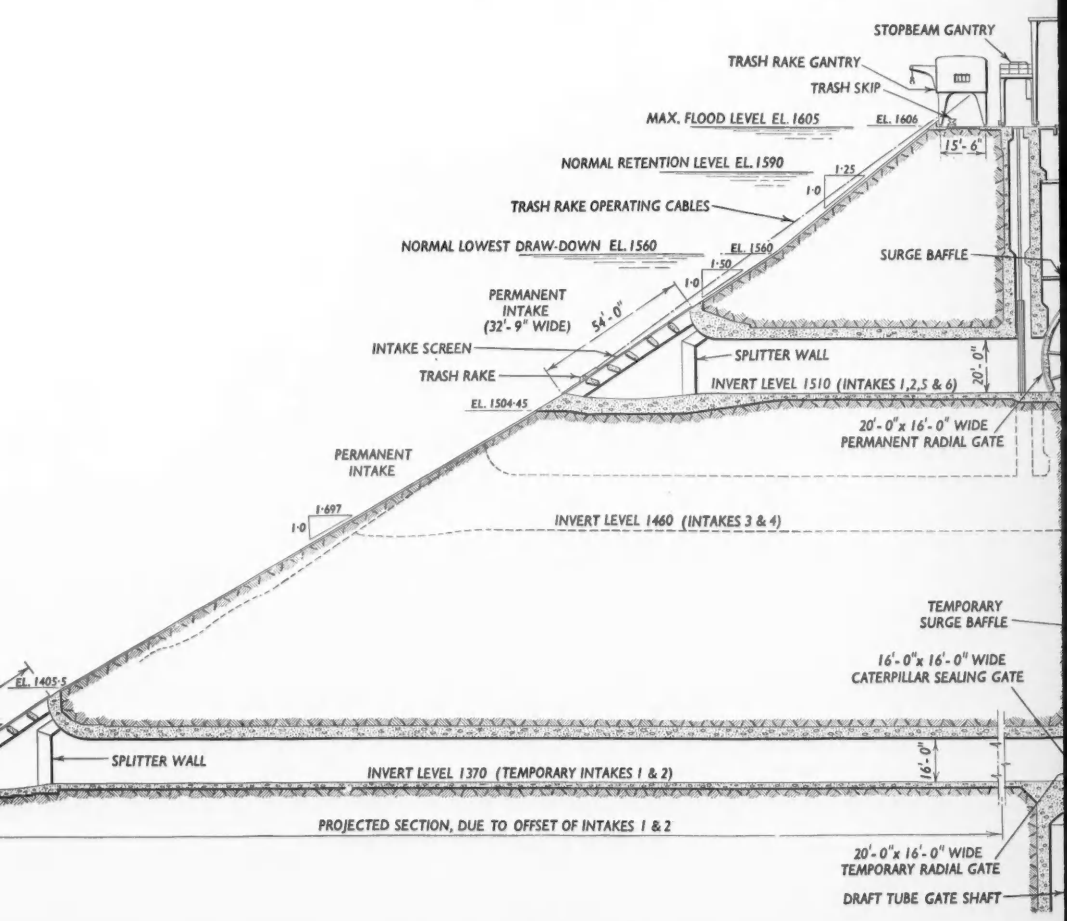


rks in plan

RIC SCHEME ON THE ZAMBEZI R

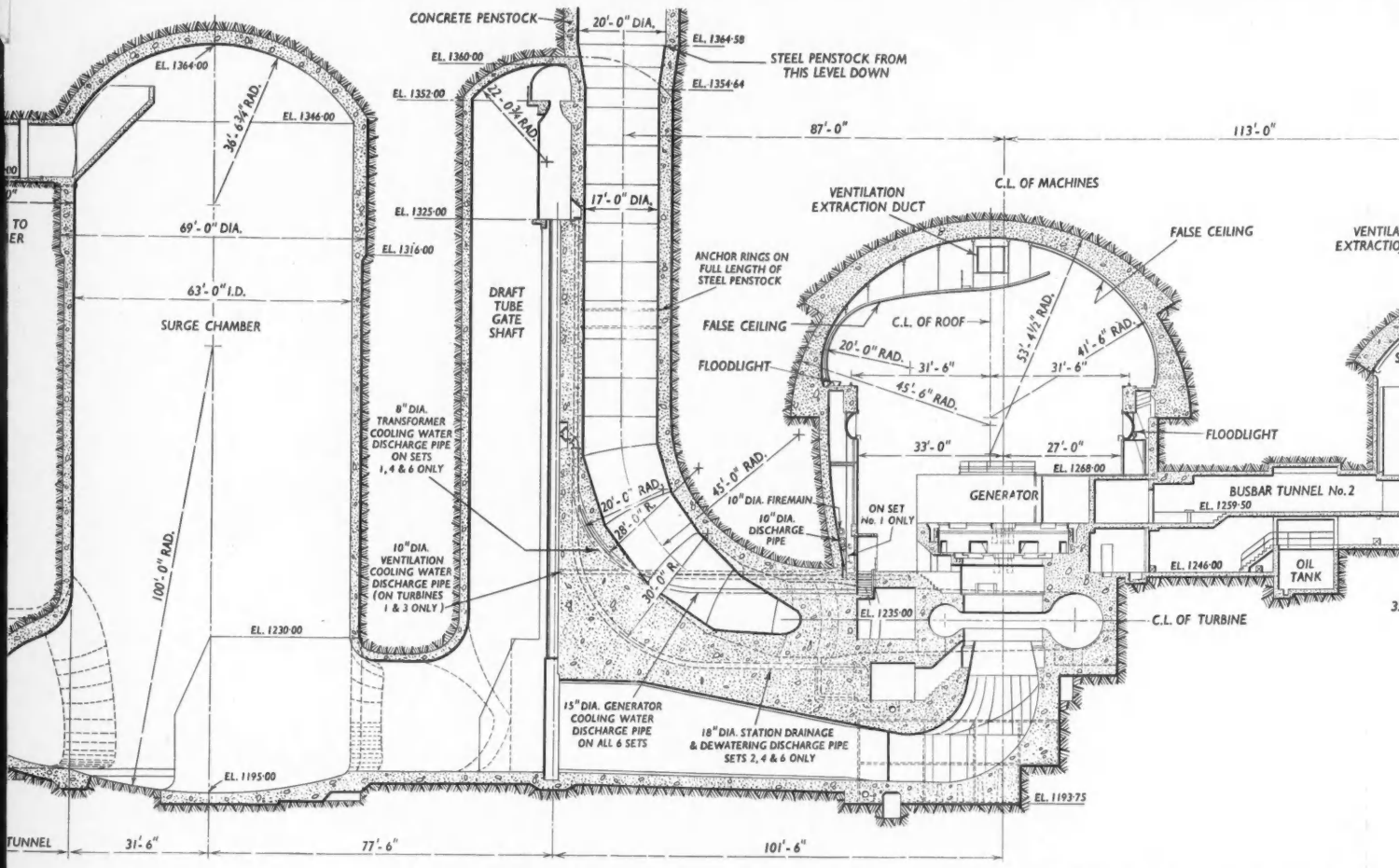


Section through underground works, showing a surge chamber, penstock, the machine hall and the transformer hall

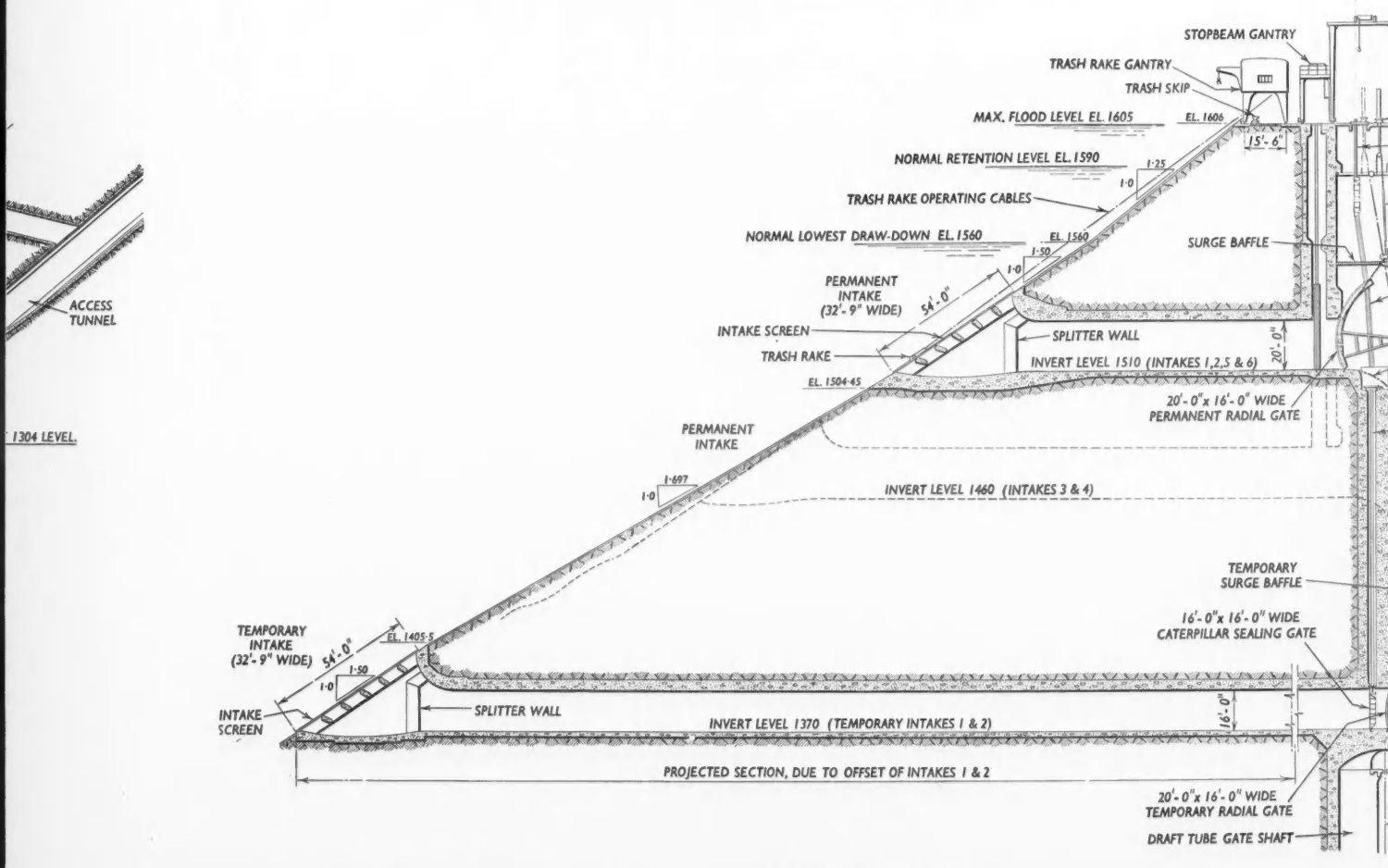


Intake and penstock details

HYDRO-ELECTRIC SCHEME ON THE ZAMBEZI RI

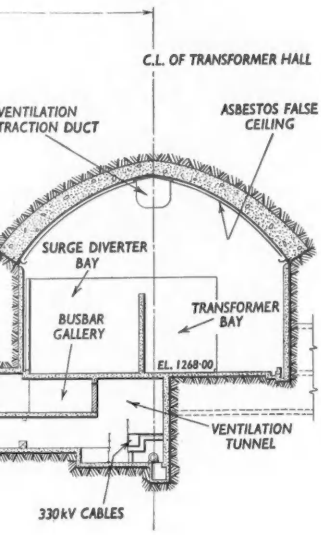


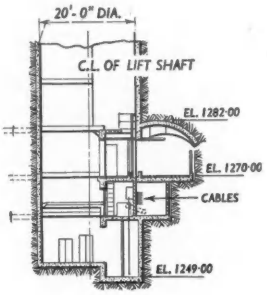
Section through underground works, showing a surge chamber, penstock, the machine hall and the transformer hall

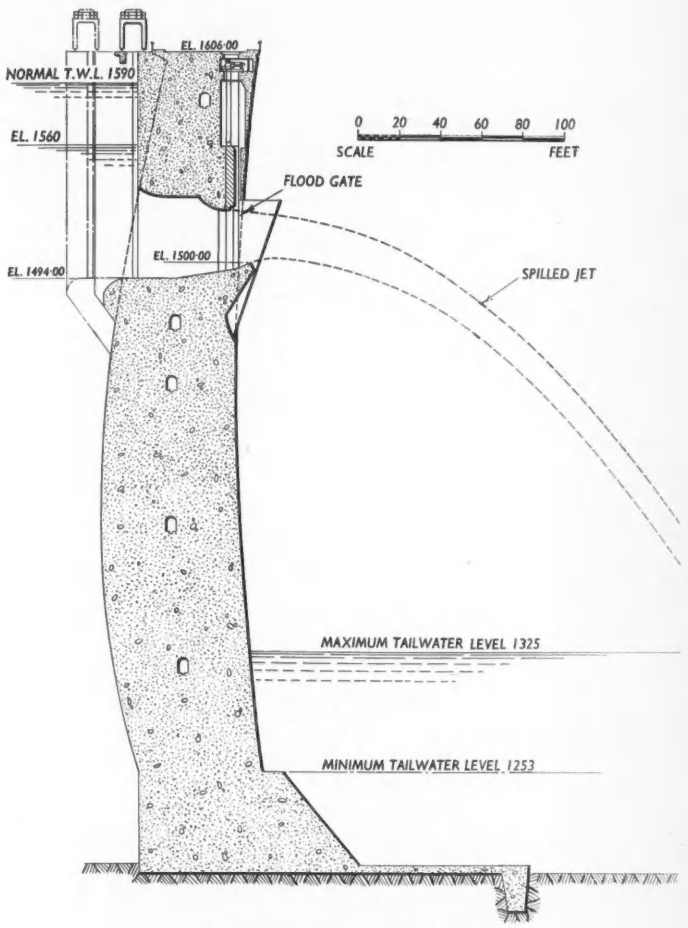


Intake and penstock details

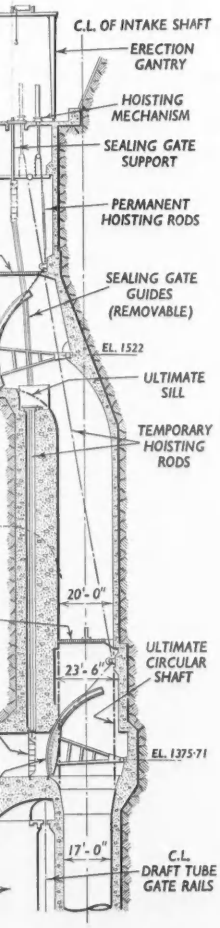
RIVER

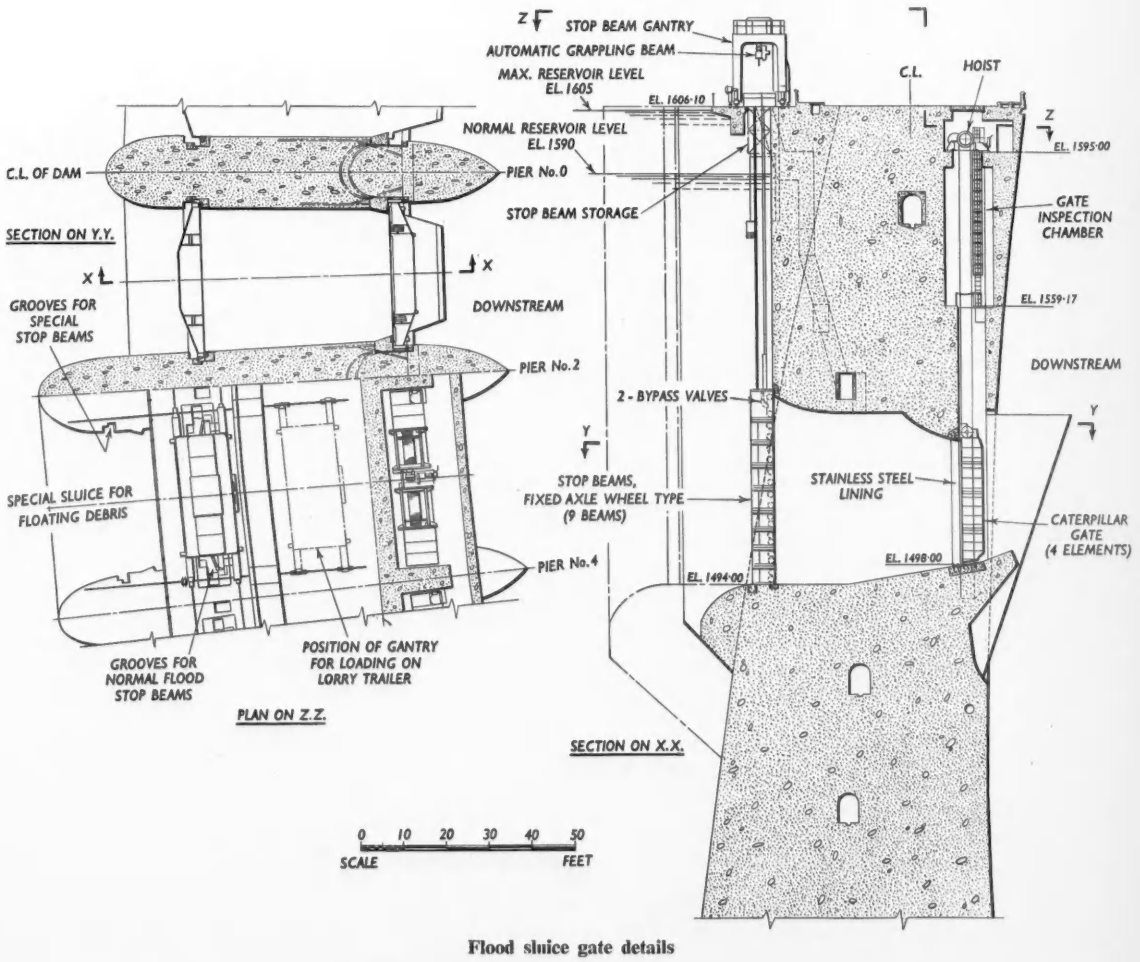






Mid-river section through the dam





Flood sluice gate details

for permanent underwater maintenance, so alternative intakes at the high level were provided for these two sets, at the same level as those for sets 5 and 6, viz. 1510ft. The sector gates erected in the low level position for intakes 1 and 2 will be lifted at a later date, when the reservoir has reached a sufficient height, to their high level position and the low level intakes will be blocked with concrete and abandoned. The intermediate intakes for sets 3 and 4 will remain permanently in use.

Model experiments were carried out to ascertain the best shape for an intake and for the upper bend, and to determine the head losses. Experiments were also conducted to study the possibility of formation of vortices. These tests were done by the British Hydromechanics Research Association.

The draught tube outlets are on the same side of the machine hall as the penstocks. It has thus been possible to incorporate each draught tube gate shaft in the same excavation as that for the corresponding penstock. Downstream from the draught tube gates, the outlets are paired into three tail-race tunnels, the equivalent diameter of each of which is 34ft. These tunnels are largely unlined. There is a surge chamber 63ft in diameter at the head of each tunnel. The machine hall is illustrated as it was before the installation of the generating sets, and Table II gives some of the principal data.

Power Station Plant

When considering the electrical and mechanical aspects of the design of the Kariba scheme, it is evident that the unique problems were concentrated on the design of the transmission system associated with it.

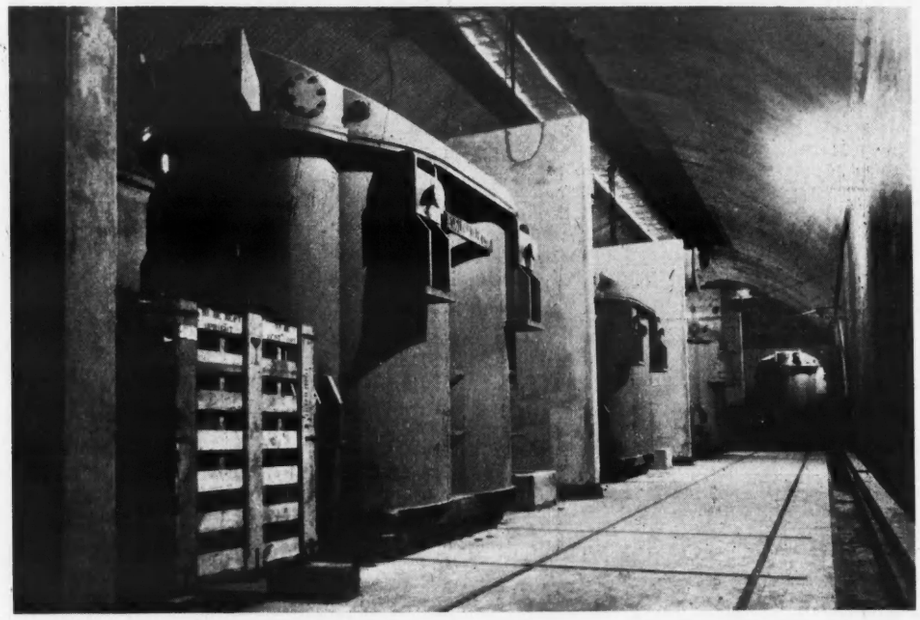
This aspect of the Kariba development has been expounded upon in some detail by Messrs. Winfield, Wilcox, and Lyon in the paper "The design of the 330kV transmission system for Rhodesia" which was published in the *Proceedings* of the Institution of Electrical Engineers. Vol. 105, Part A, 1958, page 580. Confining attention here, therefore to the scheme itself, we find that the power station design was largely straightforward, as far as this generalisation can be made for any major power station, and the dominant problems were practical ones occasioned by the remoteness of the site and thus involving shipping and handling difficulties. For these reasons single-phase transformers were specified, and the alternator stators were each constructed in quarters, which were assembled at the site.

The turbine runners were the largest pieces of the turbines to be shipped as a whole, and are 13ft 6in in diameter and weigh 40 tons. They are of cast and fabricated construction and have eighteen stainless steel blades. Other turbine and plant data are given in Table II. The turbines are vertical-shaft Francis machines, scale models of which were constructed and tested to demonstrate that the design efficiency would be achieved and that the runners would be free from cavitation troubles.

The generators, which are directly coupled to the turbines and, therefore, run at the same speed of 167 r.p.m., are umbrella machines, that is, the rotor is mounted above the guide and thrust bearings. The thrust bearings and the air which circulates through the generator windings are cooled by water drawn from the turbine spiral casings. The generator voltage is 18kV and the capacity of each generator is 100MW at 0·9 power factor (111MVA). Excitation is by a 364kW, 360V, d.c. machine fitted to the generator and controlled by a combination of rotating and static magnetic amplifiers. Auxiliary equipment includes built-in fire-fighting equipment initiated by thermostats in the hot air circuit, a high-pressure oil-operated rotor jacking system, governor and bearing oil purification equipment, and an air compressor unit for braking.

The machines are designed for a normal speed rise of 21 per cent when full load is suddenly thrown off. The runaway speed with the guide vanes fully open and no load on the generators, is nearly double the normal speed.

The transformer hall (illustrated herewith) houses the generator and station transformers and surge diverters, and station transformer switchgear. The transformers are arranged in banks of three single-phase units with one stand-by machine. The capacity of each bank (i.e. 240MVA) is equivalent to that of two generators, each of which is connected to separate 18kV windings on the transformers. A common 330kV winding delivers power by 330kV cables to the switching station, at the surface, as mentioned earlier, and thence to the transmission system where 330kV oil circuit breakers of 7500MVA fault capacity control each pair of generators and each outgoing feeder.



The first transformer bank in the underground transformer hall. The spare compound and its transformer are in the background

The transformers are not fitted with tap changing equipment since the required variation in voltage can be obtained from the generator exciter system. The transformers, like the generators, are cooled by water drawn from the turbine spiral casings. They were, in fact, nearly the heaviest shipping loads, each one weighing 98 short tons when arranged for transport.

Reactors of 20MVA capacity are installed in certain places at the extreme ends of the transmission lines. As the load transmitted over the system grows it will be necessary to replace the shunt reactors by synchronous compensators.

The generator switchgear which is used to connect the generators with the transformers is unusual in that both its current rating and short circuit rating are very high for such a low voltage as 18kV. The current rating is 4000A, while the short circuit rating is 1500MVA. They are air blast devices and are designed to have an opening time of 0·03 second and to have a total break time of 0·05 second. The generators, station transformers, generator transformers and switchgear are connected by hollow square sectional copper busbars.

Surge diverters are connected to the 330kV terminals of the generator transformers. These pieces of equipment have the function of discharging surge currents to ground when the voltage at the transformer terminals rises above a certain specified value. Such surges may occur due to lightning action in the vicinity of the transmission lines and unless by-passed by the surge diverters could cause serious damage to the windings of the transformers.

The oil-filled cables connecting the high-voltage terminals of the transformers and the 330kV switchgear in the switching station are unusual in their length—they were shipped in complete lengths of about 600 yards—and in the difference in head of about 600ft which results in a hydrostatic pressure of the oil of approximately 250 lb per square inch. These cables were described quite fully in THE ENGINEER of January 15 last, page 98. The 330kV switchgear in the Kariba switching station and in the substations within the Federation is of the bulk oil lenticular tank type having six breaks per phase.

In this description of the power station plant, we have come within the field of responsibilities of the electrical and mechanical consultants at Kariba, Messrs. Merz and McLellan. The principal contracting firms who supplied the plant are as follows: turbines, Boving and Co., Ltd.; generators, Associated Electrical Industries Export, Ltd. (contracts were originally placed with the Metropolitan-Vickers Electrical Export Company, Ltd.); generator 18kV switchgear, Brown Boveri, Ltd.; generator transformers, The English Electric Company, Ltd.; 330kV switchgear, A.E.I. Export, Ltd. (formerly B.T.H. Company, Ltd.); substation transformers, Ferranti, Ltd.; overhead electric travelling cranes in power station, Babcock and Wilcox, Ltd.; shunt compensating reactors, C. A. Parsons, Ltd.; 330kV oil-filled

cables British Insulated Callenders Cables Ltd. The six generators were built at A.E.I heavy plant division, Manchester, the 330kV switchgear by the firm's switchgear division at Willesden, and certain cables were made by Siemens Edison Swan, Ltd., another A.E.I. company. The 330kV switchgear contract was one of the largest placed with a British manufacturer, involving twenty-five 330kV circuit breakers for the seven substations, and more than 100 isolators. The substation transformers are fourteen in number, and of 120MVA or 60MVA capacity.

Costs and Finance

It is considered to be rather an unusual, if desirable, point about the Kariba scheme that it has been completed according to schedule, in spite of the floods, at less than the estimated cost. The approximate cost of the first stage is given as £79,400,000, which is equivalent to £132 per kilowatt for the complete first-stage installation of 600MW. The cost including the second stage, however, is estimated at £119·4 million, which for the total installation of 1500MW will give a cost of £80 per kilowatt. These figures include the cost of the transmission. Of the first stage cost of £79,400,000, about half is the direct

Table II—*Power Station Data*

Dimensions of machine hall :	
Length	468ft
Width	75ft
Height	132ft
Dimensions of transformer hall :	
Length	537ft
Width	55ft
Height	60ft
Turbines :	
Maximum gross head	352ft
Mean net head	310ft
Full-load rated output at 282ft net head	140,000 b.h.p.
Corresponding rated flow through turbine	4,750 cusecs
Diameter of turbine runner	13ft 6in
Weight of runner	40 tons
Alternators :	
Operating speed	167 r.p.m.
Maximum continuous capacity at 0·9 power factor	100MW
Generator voltage and frequency	18kV, 50 c/s
Diameter of rotor	25ft 6in
Weight of rotating parts of alternator and turbine together	475 tons
Total load on thrust bearing (i.e. weight of rotating parts plus hydraulic thrust on turbine)	660 tons
Overall diameter of alternator	32ft
Total weight of alternator	720 tons
Transformers :	
Transformer type and rating	Single-phase, 80MVA, 18/330kV
Number installed	Ten

cost of the civil engineering works, nearly a third the cost of the plant and the transmission system, and the rest is the cost of resettlement of Africans, administration and other financial charges. The World Bank lent £28,500,000 towards the first stage, £20,000,000 was raised by the copper industry of Northern Rhodesia, the British South Africa Company contributed £4,000,000 and private banks in the Federation a further £4,000,000. It is interesting to compare these figures with the annual budget of the Federation, which, for a population of 7,000,000, is about £60,000,000, of which about £20,000,000 is available for investment.

Concreting of the dam was finished last June as we have already noted. Commercial power was first delivered from the Kariba power station however on December 28, 1959, just before the target date of January 1. At that time one generating set was in commission. Now two sets are in service, and a third will also be in service this year. Two more will be completed next year, and the sixth and last set of the right bank station (i.e. the completion of the first stage) will go into service in 1962. It is expected that construction of the second stage power station will start in 1962, and the generating sets will be commissioned in it over the period 1967 to 1972.

Preliminary Report on the Malpasset Dam

THE failure of Malpasset dam was recorded in this journal in our issue of December 11 last. The dam was a thin arch structure with a height of about 60m, and it impounded a large reservoir for regional water supply in the Var department on the French Mediterranean coast. The failure of the dam was catastrophic, and the floods downstream caused a major disaster in the town of Fréjus.

We have just received a copy of the preliminary report of the Commission of Inquiry which was set up by the French Ministry of Agriculture to investigate the causes of the failure of the dam. The report is dated February 29, and is signed by the president of the Commission, Monsieur Gosselin. A full report is promised later on, which will include recommendations on the methods needed to avoid a repetition of such a catastrophe. The following paragraphs consist of the Commission's conclusions so far, and its discussion of them, translated and abstracted from the report.

(1) In visits to the site, the Commission established that blocks of concrete originating from the lower part of the broken dam had pieces of rock closely bonded to the concrete, and the rock was sound. This essential verification established that the dam had been correctly founded and the concrete-rock joint correctly constructed.

(2) The concrete was sampled from blocks which had been carried 200m to 1500m downstream by the failure. Satisfactory compressive and tensile strengths were measured. In one case a sample was taken across a construction joint ; a strength closely similar to the other samples was obtained, implying that the joints had been well made. The Commission considers that the concrete conformed to accepted practice ; the consultants had verified that the porphyry from the quarry was not subject to alkali reaction and gave good aggregates, and that the sand was the best available locally. Quality control in construction had been regular.

(3) The concreting itself and the grouting followed the classical methods.

(4) The reservoir had not been filled according to normal conditions, and linked with this, measurement of the deformations of the dam had not been undertaken early enough to establish its initial state before filling. The dam never spilled. There was thus no erosion of the toe or at the slopes of the valley.

(5) Three hours before the failure, the attendant opened the scour culvert, which had not been done for about a year, but had been done on about twenty occasions earlier. This was done under perfectly normal conditions, the attendant affirmed categorically. Scour culverts insufficiently aerated on the downstream can induce dangerous vibrations, but the design of this device at Malpasset assured perfect aeration of the downstream jet.

(6) The jet issuing from the scour culvert was correctly oriented, and in conjunction with the apron of concrete under the spillway, all precautions had been taken against erosion due to the energy of water issuing from the scour culvert.

(7) The Commission investigated whether any major earthquakes had been detected prior to the catastrophe. There were none.

(8) The Commission also considered that micro-seismic phenomena had no effects.

(9) The suggestion of sabotage is not tenable. Detailed reasoning is given to support this statement.

(10) The hypothesis that the fall of a meteor caused the failure is remote.

(11) Live shells were found in the reservoir; they played no part in the destruction.

(12) The Commission undertook verification of the theoretical calculations of the arch for different values of the ratio of the elasticity of concrete to the elasticity of the rock. The design calculations for the dam had been undertaken by normal methods and were correct. Nevertheless, a "trial load" analysis has been asked for by the Commission, primarily to get a better approximation to the loads transmitted normally at the left bank abutment.

(13) Examination of the dam after the failure showed, on the one hand, appreciable displacements of the left bank abutment, and, on the other, movement of the existing parts of the dam which were displaced, with the exception of the extreme right bank. This observation, linked with paragraph (1) above, shows that the principal cause of the catastrophe was a rupture of the rock below the foundations, a rupture which induced substantial displacement—notably of the abutment—and the ruin of the dam.

Further Investigations of the Failure

In further work, the Commission will try to explain more precisely the exact mode of failure. The following points will be examined : grouting for water-tightness was done by established methods, following the results of test injections, but these tests showed that the absorption of grout was very small ; the general impermeability of the bedrock, good in itself, hindered the flow of accidental infiltrations susceptible then to induce uplift pressures. Thus, certain events in the life of the dam have perhaps helped to encourage the infiltration of water, weakening the foundations, notably in the interior of the dihedron swept off the left bank, a dihedron defined by a continuous plane on the downstream, and by successive planes on the upstream, corresponding to tectonic cracks : these are the carrying out of blasting at the time of the construction of the neighbouring trunk road, movement of a dam with its upper parts exposed to the sun's rays and expanding the more freely because the reservoir was not completely full, and also the exceptional rains the last days before the failure, which caused infiltrations having paths in certain planes of fracture.

The Commission has undertaken two important studies : (*a*) determination of the modules of elasticity of rock *in situ* by direct measurement from a tunnel ; (*b*) determination by seismic methods of the mechanical properties of the rock *in situ* and of its sensitiveness, notably to explosions.

Sound Sample

The Commission hopes that these studies will lead it to an explanation of the mechanism of the failure, and to formulate recommendations to avoid a similar catastrophe again. It affirms that the technique of the thin arch dam is not questioned, such dams being perfectly secure, providing the abutments are in such a state as to support permanently the loads transmitted by such a structure.

Direction Signs for Motorways*

By R. L. MOORE, M.Sc., A.Inst.P., and A. W. CHRISTIE, M.A., B.Sc.

This article considers various aspects of the problems of designing a suitable system of direction signs and compares the system introduced on the Preston By-pass with new systems being introduced in Germany and the U.S.A., two countries with considerable experience in the operation of motorways.

THE purpose of a traffic sign is to convey information in an unambiguous way to a driver travelling at speed ; it must therefore be designed in relation to the capabilities of the driver and to the amount and speed of traffic and the road layout. The signs for motorways require particular attention because average speeds are high.

The principal requirements for all direction signs are that they should be sufficiently conspicuous for them to be picked out at an adequate distance ; that they should be sufficiently legible and sufficiently easily understandable for drivers to be able to take in their message without having to divert too much attention from the task of driving ; and that they should give this information sufficiently far in advance of the point at which action is required for drivers to be able to get into the appropriate position on the carriageway and to make the appropriate signals and the necessary adjustments in speed without endangering themselves or other road users. On high-speed motorways a more elaborate system of signing is required than on ordinary all-purpose roads. For example, direction signs must be enlarged and additional signs provided well in advance of interchanges.

Colour

It is generally agreed that there should be a difference in brightness as well as a difference in colour between the legend and background of a sign : one should be light and the other dark. The first decision that has to be made, therefore, is which way round the brightness contrast should be. For small signs a light-coloured background helps identification against the usual background of hedges, fields, &c. Signs of the size of those used on motorways are, however, sufficiently conspicuous whichever way the brightness contrast is and there are two good reasons for having such signs with dark backgrounds.

The first is that there is a slight gain in legibility by both day and night if the lettering is light and the background dark. It was found that observers, when forced to read letters at extreme range, misread only 30 per cent of white standard traffic sign upper-case letters on black, traffic blue or traffic green grounds, but misread approximately 40 per cent of similar signs having black letters on a white ground. In addition, there was a slight but smaller advantage in using a dark background when a slightly off-white reflectorising sheet material was used in place of the white parts of these signs. In night tests the same differences were obtained when signs having bright letters on a dark ground were compared with signs having dark letters on a bright ground. Similar day[1] and night[1, 2] results have been reported from the U.S.A. These results can be explained in terms of the phenomenon of irradiation : the retinal image of a white area tends to spread into that of an adjacent dark area and this is more disturbing when the white area is large, as in the sign with a white background.

The second reason for choosing signs with a dark background is an economic one. As electric power is not always available to provide lighting at night, signs may have to be reflective so that headlights supply the illumination and it is cheaper to make the legend reflective than the background, because there is less of it. Furthermore, it is desirable to make the light-coloured part of the sign reflective in order that the illumination from headlights will reinforce the brightness contrast due to the fading daylight at dusk. It follows, therefore, that the letters should be the light-coloured (and reflective) part of the sign.

Having settled which way the brightness contrast should be, there are a number of possible colour combinations. A white legend on a blue ground is used on the German autobahnen, and a white legend on a green ground is used on the Interstate System of Highways in the U.S.A. For the Preston By-pass signs with a blue ground were eventually chosen.

Lettering

In Great Britain an upper-case sans serif script has hitherto been used on road signs but in some other countries a lower-case script is preferred. There is, however, little direct evidence to show that one is better than the other and a fair comparison is difficult. Evidence relating to printed books cannot be assumed to be relevant here, for the reader of a book wishes to read quickly for considerable periods, usually at much less than the maximum possible legibility distance whilst a driver wishes to read a short message, on a sign at the maximum possible range. An extensive investigation was carried out in the United States of America[3] with single-name signs, using the scripts shown in Fig. 1. This experiment is described in an Appendix ; only the main conclusion is discussed here.

A comparison was made between the legibility of pairs of words such as Berkeley and BERKELEY. The signs tested were similar to those in Fig. 1, except that each had a single name. It was concluded that when the x-height of the lower-case lettering (i.e. the height of small letters without ascenders or descenders such as a and x) was equal to the height of the upper-case letters (capitals) the legibility distance of the lower-case signs (with familiar and expected names) was the greater by approximately 10 per cent. This is thought to be because the ascenders and descenders of such letters as b and g impart a characteristic shape to a lower-case name which enables a driver to recognise it before he can read each letter. However, in these American tests the lower-case signs had an advantage in that the letters were, on the average, taller than the capital letters due to the use of a large initial capital and the extra height of letters with ascenders or descenders. A strong advocate of capital letters might therefore consider the test unfair.

Furthermore it may not be satisfactory to rely on comparisons of single-line signs

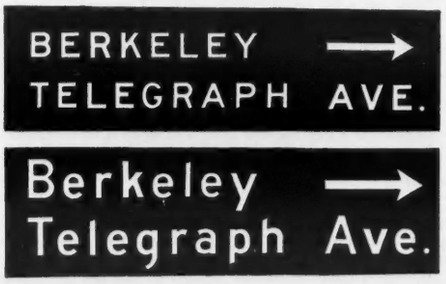


Fig. 1—Comparison of upper and lower-case scripts. The signs are of equal area and the height of upper-case letters equals x-height of lower-case letters where x-height means height of small letters such as "a" and "x"

alone ; signs frequently contain "stacks" of names and with a lower-case script the possible interference between the ascenders and descenders has to be considered. In practice, the important questions are : "How can information be displayed most economically ?" and, because the area of the sign largely determines the cost, "How can maximum legibility be obtained from a given area of sign ?"

The American authors tried to estimate the relative merits of upper- and lower-case scripts for multi-name signs using the following conventions :

(i) The signs were of equal area.

(ii) Height of upper-case letters was equal to the x-height of the lower-case letters.

(iii) The average height of the interlinear spaces and the upper and lower margins

* Communication from Road Research Laboratory, Department of Scientific and Industrial Research.

was equal to the height of the letters on the upper-case sign and the x-height on the lower-case sign. An example of a pair of signs made up in this way is shown in Fig. 1. From the results on the single-name signs they estimated that the lower-case signs would have the greater legibility distance.

However, since the ascenders and descenders project into the marginal and interlinear spaces when using the lower-case script, it would seem fairer in comparing the two scripts to reduce these clearances in the upper-case script by enlarging the letters and this has been done in the example shown in Fig. 2 (*a*). Here the interlinear space and margins in the upper-case sign are only

Fig. 2 (*a*)—These lower-case and sans-serif upper-case were compared in an experiment; the signs are of equal area, height of upper-case letters is 4in, lower-case 3½in (x-height) with 4½in capitals. The upper-case is standard lettering for road signs; the lower-case was designed by Mr. Jock Kinneir.

(*b*)—An upper-case alphabet with serifs designed by Mr. David Kindersley. The serifs are to emphasise the terminations of the strokes

70 per cent of the letter height, but in the lower-case sign they are equal to the x-height. The two signs in the figure are of equal area, and this modification leads to 4in capitals and 3½in lower-case letters.

In a test at the Laboratory a group of observers read this upper-case sign at a distance which was about 5 per cent greater than that at which they read the lower-case sign. Although this experiment does not demonstrate conclusively the superiority of either type of script it shows that the relative legibility distance of upper- and lower-case signs depends on the conventions adopted for spacing, and suggests that it is unlikely that major gains in legibility distance are possible by changing from good examples of one script to good examples of the other. The same probably applies to the use of serifed letters (see Fig. 2 (*b*)). The problem of lettering design for signs is, however, one that has raised some controversy and it would be interesting to carry out a more extensive investigation.

Size of Lettering

More important than the choice of style of script is the choice of the size of lettering to use because the smaller the lettering, the shorter is the distance at which a driver can read the sign, and consequently the greater is the angle by which he must divert his gaze from the road ahead. It is thought that if this angle is small enough the driver can see both the sign and the road ahead with sufficient clarity to be able to read the sign whilst still taking in what is happening ahead. In Fig. 3, if the angle represents

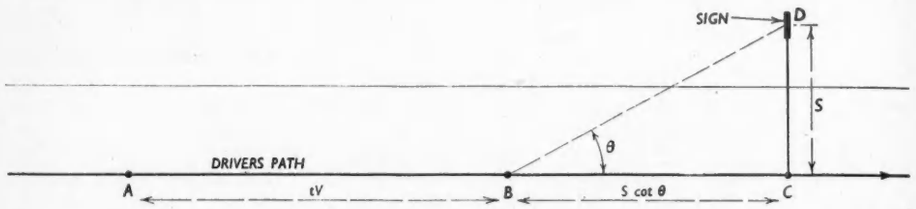


Fig. 3—Calculation of letter size by the method proposed by Mitchell and Forbes.[5] If θ is the maximum acceptable divergence angle the driver should finish reading the sign before reaching point *B*. If the driver takes t seconds to read the sign and is travelling at Vft per second, the letters must therefore be large enough to enable him to begin reading at point *A*

the maximum acceptable divergence angle the driver should have finished reading the sign by the time he has reached the point *B*, a distance $BC=S\ \cot\theta$ft in advance of the sign, where *S* is the sideway displacement in feet of the sign from his path. To obtain the distance at which a driver needs to be able to begin reading the sign it is necessary to add the distance *AB* which he travels whilst actually reading it. Thus if he takes seconds to read the sign and is travelling at a speed of *V* feet per second he should be able to begin reading the sign at point *A*, in Fig. 3, which is a distance of *tV*ft in advance of the point *B* and a total distance $AC=tV+S\ \cot\theta$ft in advance of the sign itself. If *L* is the distance at which the driver can read letters of the type considered, expressed as feet per inch of letter height, then the minimum possible letter height, in inches, is given approximately† by

$$H=\frac{tV+S\ .\ \cot\theta}{L}.$$

According to Mitchell and Forbes,[5] on whose work the design of highway signs in the U.S.A. is largely based, it is advisable to give a driver two chances to read the sign in case his view is obstructed by other traffic when he should be reading it, i.e. *tV* in the above formula should be replaced by 2*tV*. In addition they recommended 10 deg. for the value of θ. Their working formula therefore becomes

$$H=\frac{2tV+5{\cdot}7S\ \text{inches}}{L}.$$

According to them $t=N/3$ seconds, where *N* is the number of simple names or words on the sign (with a minimum value *t*=one second), and *L* may be taken as 50ft per inch of letter height (x-height where lower-case lettering is used). For a motorway with a three-lane carriageway on which *S* may be as much as 50ft and for a design speed of 103ft per second (i.e. 70 m.p.h.) the formula gives the distance at which a driver should be able to begin to read a sign containing six names as 700ft, and the necessary letter height as 14in.

The values used by Mitchell and Forbes[5] for the quantities *L* and *t* in their formula may be checked against values derived from research work recently carried out in the United Kingdom, namely:

(1) The minimum legal vision requirement for a driver is that he should be able to read 3½in letters in daylight from 25 yards away. For such drivers, *L* would be 21ft per inch, but, because most people have much better vision, it is estimated, from data published by Davey,[6] that a value of *L*=50ft per inch would cover the requirements of about 98 per cent of drivers on the road, and the value is therefore probably a reasonable one with which to work.

(2) From work carried out at the Road Research Laboratory it is concluded that, although $t=N/3$ represents fairly well the average time in seconds to find the required name amongst the *N* names on a sign, longer times are often required. This is because the searched-for name is sometimes one of the first to be read and sometimes the last. Therefore to cover the cases when a driver is unlucky enough to have to read all the names on the sign, a time of $t=2N/3$ might be more appropriate. Thus, although the formula of Mitchell and Forbes[5] is intended to allow drivers two chances to read a sign in practice it allows sufficient time for only one chance for drivers who are unlucky enough to have to read all the names on the sign before coming to the one they want.

(3) Tests are being carried out to see whether it is meaningful to specify a maximum divergence angle θ. To do so presupposes that it is possible for a driver to divide his attention, and this is a matter for further investigation.

Taking into account all these points and the fact that all the information on the time taken to read signs, and the distances from which they can be read refer to clean signs, good daylight, and clear atmospheric conditions, it is concluded that it would be unwise to erect signs on motorways with letters of less than an x-height of 12in. This would be in line with present American practice, based on much experience; the manual on signing on the Interstate Highways,[4] for example, requires a minimum lower-case x-height of 12in at ordinary interchanges, but the desirable height is given as 15in. For major interchanges the minimum place-name height is 18in. On the other hand, smaller letter sizes are permitted on the German autobahnen.[7] A formula similar to the above is used, but the divergence angle θ is taken as 15 deg., and no allowance is made to give the driver a second chance to read the sign, with the result that letters with an x-height of about 8in are permitted.

Information Content

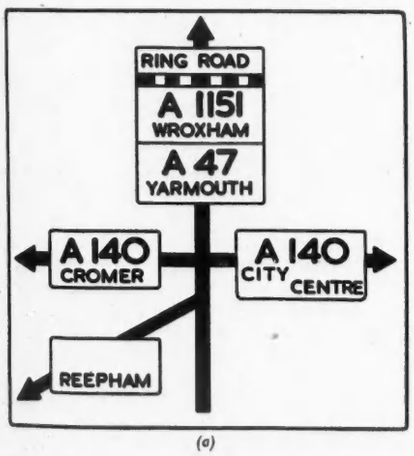
The greater the amount of information on a sign the greater is the distraction from the

† *BD* can be replaced by *BC*, and *AD*, by *AC* for small values of θ.

task of driving. It has already been noted that it is necessary to increase the size of the lettering as the information content is increased in order to limit the angle through which the driver must divert his gaze. However, it is also desirable to limit the time during which his gaze is diverted by restricting the amount of information on the sign to that which is strictly necessary. Conventions concerning the information which should be given on direction signs vary from country to country. In the United States of America on motorways it is planned to limit the information on direction signs to four lines of print, e.g., route numbers of the road to which access may be obtained at the interchange ahead, one destination in each direction on that road and a simple instruction such as "EXIT 1 MILE." In Germany more information is permitted on a single sign ; advance direction signs may include reference to more than two destinations on the connecting road and European route numbers if applicable.

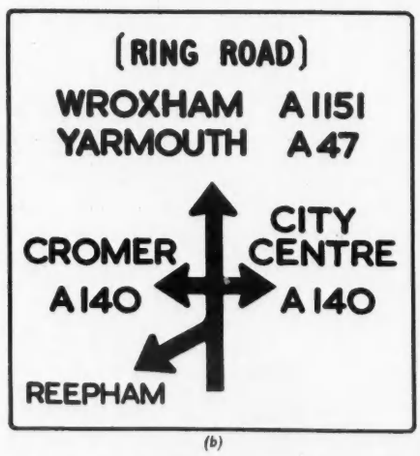
Layout in Relation to Size of Sign

The layout of British advance direction signs for ordinary roads has been standardised for some years by Ministry of Transport regulations, the 1957 edition now being in use. The type of sign generally seen consists of a back-plate on which a plan of the junction is marked with arrows, each of which carries a panel bearing both place name and road number. Experiments reported more fully elsewhere[8] showed that the use of small panels made it impossible to utilise the full area of the sign to best advantage. By doing away with the small panels but retaining the map feature as is done on the Continent (see Fig. 4) considerably larger lettering can be used for a given area of sign. Another alternative is simply to arrange the names in a stack with a short arrow opposite each name as is common in the U.S.A.



(a)

Fig. 4 (a)—Complex intersection as shown in the 1957 regulations. (Type 437,P.51)



(b)

Fig. 4 (b)—The same intersection as it would appear with a Continental type of sign

Two preliminary designs for motorway signs have been suggested by the Laboratory. That with the heading to this article follows the American pattern, and Fig. 5 the Continental pattern. The layout finally selected is shown in Fig. 7 (*c*).

The overall size of the sign is dependent on the size of lettering required, the amount of information to go on the sign, the form of layout adopted, and the spacing allowed between letters, between names and between the legend and the edge of the sign. Within limits, an increase in spacing improves legibility, but there is evidence to show that where the maximum legibility distance is required with a given size of sign the legend should be made as large as possible nearly filling up the available space. Thus the most economical design of sign may not be the most pleasing æsthetically.

Siting of Signs in Relation to the Carriageway

There is agreement that signs on the nearside should go outside the hard shoulders, which are a normal feature of modern motorways. In the United States of America, signs are mounted with their lower edges at a minimum height of 7ft above the carriageway in order to minimise the effect of dirt. In Germany they are often mounted lower, and their legibility suffers from mud splashed up by vehicles. Although mud is deposited as a fine spray it gradually builds up a layer, which has a serious effect on legibility. Tests carried out in Great Britain showed that the reflective power (in headlights) of a small reflective sign positioned 7ft 6in from the edge of a busy road and 4ft above its surface fell to 60 per cent of its original value after exposure for four weeks during which time ½in of rain fell. Similar work carried out in the United States of America[9] makes it clear that even when the signs are sited beyond a hard shoulder, 12ft wide, the effect of mud-splash, although reduced, is still present. However, it is often not possible to site them further away because of cuttings or embankments, and it is undesirable where reflective signs are used because it would place them outside the main beams of headlights.

A further important point about the siting of signs is that they should be turned so that no mirror reflection from the glossy surface of the signs can be returned to the eyes of the driver using headlights at night, otherwise the message will be obliterated. To avoid this, the sign may be turned away from the road by a small angle. Too often at present, one finds a sign turned in towards the road so that drivers at some point or other see it square-on. If signs were perfectly flat a very small rotation away from the road would suffice, but they are not ; experiments on the Preston By-pass showed that on a straight road and on a right-hand bend a rotation of 2–4 deg. is sufficient to eliminate these reflections. On a left-hand bend the 2–4 deg. should be measured from the perpendicular to the chord joining a point on the edge of the carriageway, level with the sign, to a similar point 600ft in front of the sign instead of, as in the other cases, from the perpendicular to the tangent to the edge of the road at the sign. An alternative method is to tilt the sign out of the vertical plane (the lower edge forward) but this appears to introduce undesirable reflections from the sky in daytime.

There is an increasing tendency, particularly in places such as California where motorway traffic is heavy, to use signs mounted on bridges over the carriageway. These structures may have a clear space of more than 100ft, and may carry the lanterns for illuminating the sign at night and sometimes a catwalk for maintenance purposes. The advantage of such signs is that they enable traffic to be marshalled into lanes by means of arrows and they are out of the range of mud-splash. Such siting is a necessity where intersections are so close that a conventional system of advance informatory signs is not possible ; on viaducts a sign bridge may be the only possible way to present road information in lettering of adequate size.

Green panel with a red hexagon

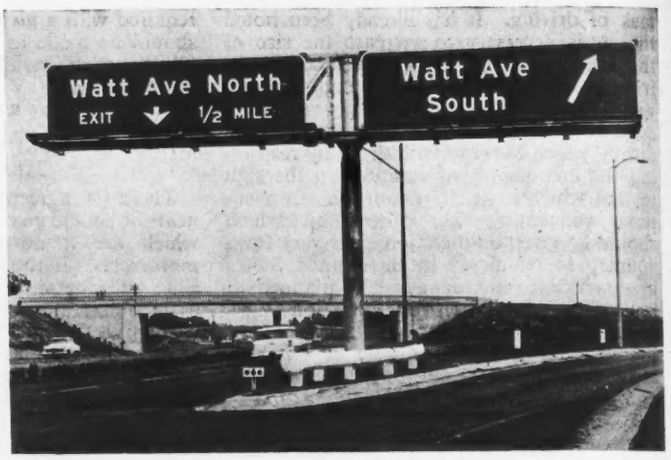
Fig. 5—Prototype sign for Preston By-pass, based on Continental practice, intended to be erected ½ mile from junction. The M6 refers to the British motorway number. A blue background was eventually chosen

At forks in the road it is sometimes difficult to find enough width to erect an ordinary sign, and signs mounted high on posts and cantilevered out over the carriageway are commonly used. Examples of overhead signs are given in Fig. 6.

Provisions for Making Signs Effective at Night

Research work carried out in Great Britain[10] and in the United States of America[2] has shown that the ideal brightness for the light parts of signs at night is in the region of 10ft *L*, a brightness that can be achieved by good reflectorising materials, when drivers are using the upper beams of their headlamps, or alternatively by floodlighting the sign. Reflective material is designed to return the light from headlamps back to the vehicle with just sufficient spread of the beam to include the eyes of the driver. The narrower this reflected beam the brighter the reflector can be made to appear. The reflection may be achieved by using either a material containing small glass spheres covering the whole of the letters or by a number of button reflectors set in the letters. In this latter case, provided a sufficient number of good-quality buttons are used, the legibility from the distances at which the sign is designed to be read is the same as if the letters were reflective all over the surface.

Using a specially designed photometer[11] measurements on reflective materials in



(Left) Fig. 6 (*a*)—Overhead signs. A signbridge on the Italian autostrade (Right) (*b*)—Overhead signs. A butterfly sign in the fork between two branches of a motorway in California

both sheet and button form showed that many examples had a very poor performance. In the case of button reflectors, particularly, the reflecting properties were often very variable and letters made of these would be patchy in appearance. The measurements, together with a theoretical investigation, enabled the Laboratory to put forward proposals specifying minimum reflecting powers of both types of material when used in signs with 3in letters, 3in to 8in letters, and letters greater than 8in. The larger lettering requires very efficient materials with a narrow return beam. These proposals now form part of the relevant British Standard.[12]

It is possible to make the dark-coloured background of the sign reflective as well as the legend, and since the reflective power of dark-coloured reflective materials is less than 10 per cent of that of a similar white reflective material for use on the legend, the brightness contrast at night between the legend and the background is not seriously affected. The advantage of this step is that the colour of the background becomes noticeable in headlights, and the target value of the sign at night in headlights is increased, although in the case of large direction signs for motorways it is debatable whether, in view of the increased cost, these improvements are worth while.

The legibility distance of reflective signs is reduced where drivers have to use the lower (i.e. meeting) beams of their headlights. From American data[2] and from tests carried out here this reduction is estimated at approximately 10 to 20 per cent. Therefore unless there is adequate screening between the opposing carriageways which will enable drivers to use upper headlamp beams, it is preferable to provide fixed lighting for signs. The standard of lighting permitted on signs on ordinary roads, B.S. 873 : 1959, is quite unsuitable for motorway road signs ; variations in the brightness of the white parts of up to 40 : 1 are permitted on signs as small as 6ft by 6ft in size. A special system of lighting has therefore been developed which gives an average brightness of about 10ft *L* and a brightness variation of about 5 : 1 on signs 20ft square. Of course, on smaller signs the performance is better still. This lighting system, which consists essentially of a line of fluorescent tubes in specially shaped trough reflectors extending across the width of the sign, is now in use on the Preston By-pass[13] and on the London-Birmingham motorway.

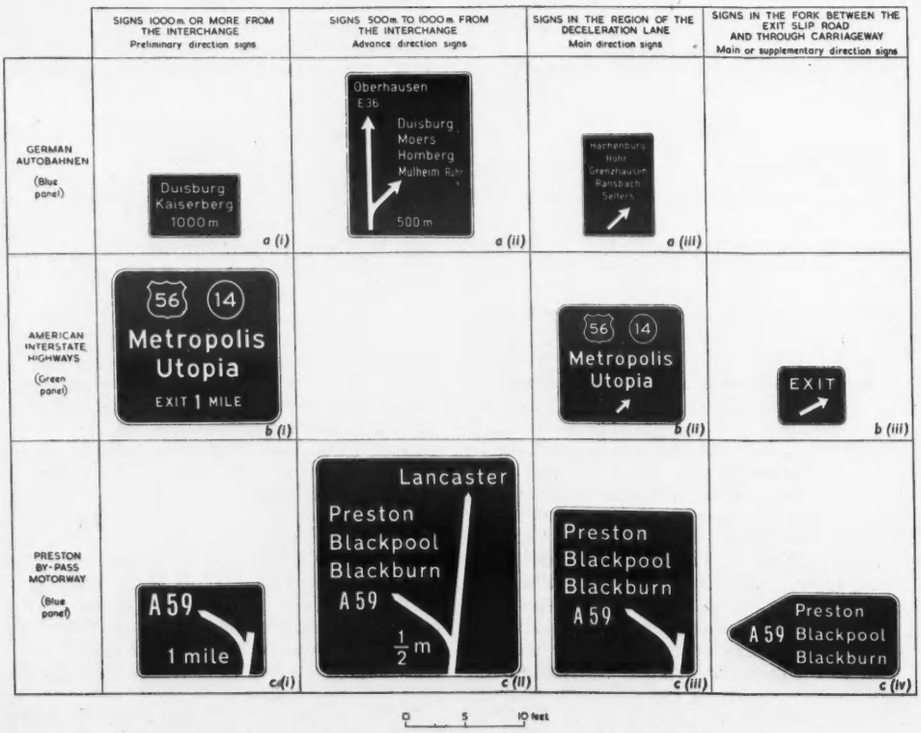


Fig. 7—Examples of direction signs on German, American and British motorways

Systems of Direction Signs

Nomenclature.—Owing to the speed of traffic, it is customary on a motorway to give several preliminary warnings of the approach to an intersection, and it is therefore convenient to name each of these signs. Usually there is some form of early warning sign bearing a brief announcement 1000m or more from the interchange (there may, of course, be more than one) ; such signs will be referred to as " preliminary direction signs." The sign which indicates that the exit slip road has been reached will be referred to as the " main direction sign." This may be at the beginning of the deceleration lane, on the central reservation opposite the mouth of the exit slip road, or in the fork of the junction between the exit slip road and the through carriageway. If the main sign is not in the fork some form of " supplementary direction sign " is usually sited there. Between the " preliminary " and " main " signs there may be other signs, often bearing detailed information and usually sited 500–1000m from the interchange. These will be referred to as " advance direction signs."

Usually just beyond an interchange there is a sign that lists some of the destinations ahead and the distances to them. These signs are to reassure through travellers that they have not passed the point where they should leave the motorway, and to reassure drivers who have just entered the motorway that they are proceeding in the correct direction along it. Such signs may be referred to as " confirmatory signs." Typical arrangements of signs at the approach to a motorway junction in Germany, America, and on the Preston By-pass, are shown in Fig. 7, and the main features of each are outlined below.

Direction Signs on German Autobahnen.—An improved system of direction signs is at present being introduced on the German autobahnen.[14] Its main features are described below. The approach to a minor interchange (with the ordinary road system) is marked by a preliminary sign at 1000m, an advance sign at 500m, and the main sign near the mouth of the exit slip road. There is a confirmatory sign 500m after the interchange. On the approach to a major interchange (with other autobahnen) the system

is more elaborate ; the preliminary sign is at 2000m, and two advance signs are given at 1000m and 500m.

The preliminary sign for a minor interchange is of the type shown in Fig. 7 (*a*) (i) listing one or two destinations reached by leaving the autobahnen at the interchange. A major interchange is given its own name, such as " Frankfurter Kreuz." Advance signs for minor interchanges are of the map type as shown in Fig. 7 (*a*) (ii), and list destinations for the through carriageway as well as for the exit slip roads. Advance signs for major interchanges may be more complicated, showing a division of the exit slip road. At the older types of minor intersection the main direction sign may consist only of a pointed sign reading " Ausfahrt " (" Exit ") in the fork between the through carriageway and the exit slip road. At more elaborate interchanges (including the newer forms of minor interchange equipped with a lay-by connecting the exit and entrance slip roads) the main direction sign is in the central reservation opposite the exit (Fig. 7 (*a*) (iii)). Sometimes, however, overhead signs are used. The confirmatory sign is of the type shown in Fig. 8.

Fig. 8—Confirmatory sign on a German autobahn

White (usually reflective) lower-case lettering on a blue ground is used with an x-height of about 8in. The illustrations appear to be typical as regards the number of names listed. European route numbers (E-numbers) are included where applicable but no national route numbers are shown. On the signs approaching an intersection the distance to the exit slip road is given.

Direction Signs on Motorways in the United States of America.—The system to be described is the new uniform system[4] being introduced throughout the U.S.A. on the National System of Interstate and Defence Highways. At a minor interchange with one exit for both directions of the road with which the motorway interchanges, the sequence of direction signs is as shown in Figs. 7 (*a*) (i–iii). The illustrations show prototype signs and do not refer to real places. There is a preliminary sign 1 mile from the exit, the main direction sign is at the beginning of the deceleration lane, and there is a supplementary sign at the actual exit. In addition, a confirmatory sign is posted ½ mile beyond the entrance slip road. The preliminary sign is of the form shown in Fig. 7 (*b*) (i) and bears the route numbers and destinations (but only one in each direction) for the road with which the interstate highway interchanges together with the distance to the interchange. The main direction sign is of the form shown in Fig. 7 (*b*) (ii). The supplementary direction sign is in the fork between the through carriageway and the exit slip road and simply bears " Exit " and an arrow, Fig. 7 (*b*) (iii). The confirmatory sign lists only two destinations and the distances to them.

At a major interchange with separate exit and entrance slip roads for the two directions on the other road, the preliminary sign is given twice, at 2 miles and at 1 mile, and there are separate main and supplementary signs for each exit. At the first exit the supplementary sign is on a sign bridge which extends over both the exit slip road and the through carriageway, and which also carries the main sign for the second exit and a lane-indicating sign for through traffic.

White lettering on a green ground is used, with lower-case lettering for destinations and upper-case lettering for written instructions. A letter height (x-height where the lower-case script is used) of 15in is recommended for minor interchanges and 18in for major interchanges. Where a fixed lighting system is not provided the lettering must be reflective (the background may also be reflective).

There is no sign corresponding to the advance sign in the German system and on the approach to an interchange no information is given concerning destinations beyond that interchange.

Direction Signs on the Preston By-pass.—The British system of direction signs tried out on the Preston By-pass comprises a preliminary sign (Fig. 7 (*c*) (i)) 1 mile from the interchange, an advance sign ½ mile from the interchange (Fig. 7 (*c*) (ii)), a main direction sign at the beginning of the deceleration lane (Fig. 7 (*c*) (iii)) and a supplementary sign in the fork between the through carriageway and the exit slip road (Fig. 7 (*c*) (iv)). A confirmatory sign, similar to that given on the German autobahnen, is sited beyond the interchange to give the main destinations ahead and the distances to them. The colour scheme is white on blue. The lettering is lower-case throughout, the normal x-height being 12in. Route numbers are included where applicable. The signs at the interchange are illuminated, those away from it, e.g. the preliminary and advance signs, have a reflective legend. The external lighting system used is that developed at the Road Research Laboratory.[13]

In most respects the British system is more like the German system than the American one. For example, a map-type advance sign is used ½ mile from the interchange (on the German system such signs are erected 500m, and possibly also at 1000m, whereas on the American system there is no sign on the approach to an interchange showing destinations on the through carriageway, and normally there is no direction sign between 1 mile from the interchange and the beginning of the deceleration lane). Other points of similarity with the German system are the inclusion of more than two destinations, the use of a white legend on a blue ground, and the exclusive use of lower-case lettering. However, the lettering used on the British signs is larger than that normally used on the German signs although it is smaller than that normally used on the American signs.

The prototype system tested on the Preston By-pass has, after slight modification, been used on the London–Birmingham motorway. The main change is that the designs for the advance and main direction signs have been interchanged, i.e. (*c*) (ii) and (*c*) (iii) in Fig. 7. This results in a progressive build-up of the information on the signs until the deceleration lane is reached with the supplementary sign ahead of the driver as he turns giving confirmation of the exit destinations as before.

Acknowledgment

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Appendix

An American Comparison of Signs With Upper- and Lower-Case Scripts.—In the investigation carried out by Forbes, Moskowitz and Morgan[3] observers walked towards an array of single-name signs of different sizes. The distances at which they could read them were recorded, by day and by night under artificial illumination.

The scripts used were as shown in Fig. 1. With the height of the upper-case letters equal to the x-height of the lower-case letters (the height of small letters such as a and x), the stroke-width and the average letter-width (including the horizontal spacing between letters) are about the same.

When scrambled upper-case letters were compared with scrambled lower-case letters (the height of the upper-case letters being equal to the x-height of the lower-case letters) there was very little difference between the two scripts. When familiar but unexpected names were used, legibility distances were slightly greater with the lower-case script. When names were used that were both familiar and expected the advantage of the lower-case lettering was more marked, the legibility distance being on the average approximately 10 per cent greater than for the upper-case lettering.

Since drivers usually have some idea of what names to expect on a direction sign the result for familiar and expected names is probably most relevant to direction signs.

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LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

CRITICAL LOOK AT THE NOVIKOV GEAR

SIR,—Dr. Harry Walker on " A Critical Look at the Novikov Gear " in your April 29 issue has my full interest. Gear engineers acknowledge his original contributions in their chosen field, so his opinions carry weight. Moreover, when he has something to say, he usually puts it in one place, which happens to be THE ENGINEER, so we know where to find him. A good plan to follow. One gets a bit dizzy trying to keep track of this discussion in so many magazines.

In the summary he writes : " The Novikov gear has its intrinsic value, and we must believe from experience that the Russians will pursue this to its ultimate conclusion . . . I cannot refrain from expressing the opinion that the Novikov gear, or something on similar lines, has come to stay." All credit to Novikov and his associates for recognising the potentialities of the system, and their pioneer development of it. But the patent record is indisputable in establishing priority, and it seems to me, at this stage in the proceedings, we should give it its proper name—the Wildhaber gear—neglected though it was at the time of its discovery. Incidentally, much of the argument here when news of the Russian Profile first came over would have been avoided had the essential fact that this particular circular arc gear is *non-conjugate*, a very rare animal in our collection, been perceived.

The independent re-invention of earlier ideas is a commonplace ; we've all done it, and usually the sad truth emerges at the patent stage. It seems certain that the late M. L. Novikov invented and developed this gear system without knowledge of what had gone on before. A thorough search of the patent files, even in one's own country, is no easy task. In any highly specialised field the patent agent in general practice is at a disadvantage. He may get there in the end, but time is money. I know only one who has concentrated on gear work, the resident patent attorney at the famous Gleason Works, now in private practice.

Another sidelight on this ; in all the Russian publications I have seen, the list of references is confined to Russian sources. They seem unaware of the existence of the outside world. It is possible that United States Patent 1,601,750 by E. Wildhaber, filed November 2, 1923, granted October 5, 1926, never came to their attention. All the characteristics of what is presently known as the Novikov gear are completely anticipated in that patent ; moreover, it indicates methods of producing hard-ground gears, which, as Dr. Walker points out, may be necessary if we are to exploit the possibilities to the full.

It is interesting, and maybe instructive, to speculate why thirty years have elapsed since this invention and its development in other hands. We have to remember the context of the times around 1920. The involute had emerged as a successful rival to the cycloid and similar forms. The benefits of correction in avoiding undercut, improved contact conditions through distribution of approach and recess, and so on, were beginning to be realised (the Maag System came out in 1917). The manufacturing advantages of the straight line generator, one hob for all tooth numbers, interchangeable series (now not so highly regarded), the trend towards standard 20 deg. pressure angle, all these things combined to assure the position of the involute form. In this climate anything in the nature of a throwback received scant attention. To quote Wildhaber : " The gearing never had a real test, although a pair of gears was made in the 'twenties." This position endured until Novikov came along.

There may be reasons, apart from technics, for the long interregnum. An inventor usually has to find a backer. The question is : What can be made from this idea ? The Russian engineers, with the vast resources of this technical age at their disposal, phrase the question somewhat differently ; What can be made of this idea ? They can detach design, drawing, and workshop effort for a promising job, even though its value in the market is hardly worth reckoning.

In trying to keep informed, to find out what makes the thing tick, to put its history in perspective, I have combed through the patents of Smith (1912), Bostock (1922), Wildhaber (1926) and Novikov (1936) ; read translations of Russian articles by Fedyakin, Chesnokov and others ; turned up Fisher's 1928 *Machinery* articles on Pin Gearing and Arc Tooth Form, and everything I could find in print up to Harry Walker's latest article. In this miniature mountain of published material the non-conjugate gears described are all speed reducing. In the usual " Novikov " gearing the pinion has convex profiles, and with the pinion driving, the contact is on the *recess side* (we can't say, as for some involutes, that the action is *all recess*, because there is no carry-over in the transverse plane, no action line, no profile contact ratio, none of the familiar properties of conjugate forms). Speed increasing gears are equally important, in any case we may have overrun, as in auto-transmissions. To keep the contact on the recess (or leaving) side of the line of centres with gears driving pinions, we could make the pinion concave, and the gear convex, but then for low-numbered pinions the profile would have to be related to the tooth number, meaning more than one hob for the range. For reversing drives, it seems we must accept that the contact shifts from one side to the other, with no chance of balancing the action as in involutes. I hope this point comes up in the discussion of Dr. Walker's excellent paper.

A. M. GUNNER

Rugby, May 8, 1960.

Book Reviews

Curve Surveying. By R. B. M. JENKINS, M.A., A.M.I.Mech.E., M.I.Loco.E. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 35s.

THIS is a well produced book which deals with the methods of calculation and the setting-out of railway and road curves rather more fully than is the case in most of the general surveying textbooks. The curves discussed are circular arcs, cubic parabolas, spirals (or clothoids) and lemniscates and their mathematical properties are very clearly explained. In the chapter on circular arcs an excellent feature is the full treatment of compound and reverse curves and a minor, though noteworthy, point raised by the author is the use of the term " deviation angle," applied to the angle between one tangent produced and the second tangent, instead of " deflection angle " which is so often confused with " tangential angle." The term " versine " is used by the author for the mid-ordinate of a chord but he points out that this is not the strict mathematical meaning of the word. In referring to the " degree " system of defining curvature only the chord formula is given, but in highway work the " degree of curvature " is sometimes taken as the angle subtended by an arc 100ft long instead of by a chord of that length.

Superelevation, and the necessity for transition curves in connection therewith, are discussed in a very competent manner, and interesting diagrams are given which show the forces exerted on the rails by coupled locomotives of various types when running on a curved track. Reference is made to the paper presented at the Institution of Mechanical Engineers in which the method of calculating these forces is explained and this should be studied if a full understanding of this important subject is to be obtained.

The simpler problem of superelevating road curves is also discussed, but the author is not quite correct in stating that the maximum superelevation used on roads is 1 in 10. In Great Britain the Ministry of Transport has specified a maximum crossfall gradient of 1 in 14½. There will be general agreement among highway engineers with the statement that " as far as possible a transition should exist on those portions of a road where superelevation is being run up," and it might be added that camber should on no account be taken out before the tangent point of a curve is reached. The planning of road transitions has not yet reached the admirable degree of standardisation now established by British Railways, but a large body of opinion among road engineers will concur with the author's view concerning the danger of a long transition leading into a circular arc of short radius. The same dangerous deception is produced, of course, by a wholly transitional curve of too great a length.

In discussing the spiral, or clothoid, it is stated that the calculations for setting out become tedious unless special tables are available, but in locating road curves in which tangential angles are often needed to no greater accuracy than the nearest half-minute, the only table required is that

giving the corrections to these angles when the spiral angle is greater than 21 deg. It is then no longer sufficiently accurate to assume that the tangential angle to any point on the curve is one-third of the spiral angle up to that point. It is true that the co-ordinates of these points can only be expressed by the terms of an infinite series, but terms beyond the second are so small that they can be neglected with impunity, and spiral calculations from first principles are extremely simple. As the author states, some engineers prefer to use Bernoulli's lemniscate as a transition curve and tables are included in the book for facilitating calculations for this kind of curve, but it is pointed out that the simpler cubic parabola is practically identical with the lemniscate for deviation angles up to 12 deg.

The final chapter deals with the string lining of railway curves by the Hallade method, with actual worked examples, a very useful feature for permanent-way engineers.

This book will be found a reliable and valuable aid by all concerned with the design and setting-out, both on roads and railways, of curves which will provide adequate safety for high-speed travel.

Work Study. By R. M. CURRIE, C.B.E. Sir Isaac Pitman and Sons, Ltd., 39 and 41, Parker Street, London, W.C.2. Price 22s. 6d.

THIS book incorporates in a very much more useful form and binding the three Work Study pamphlets previously issued by the British Institute of Management. There are certain minor revisions and some new sections and all terms have been brought in line with the 1959 British Standards Institution "Glossary of Terms in Work Study." The final chapter, in particular, on Work Study as a service to management, is a useful summary of present-day applications and objectives. Mr. Currie says in his preface that his book "is in the nature of a 'pioneer' in the field," and although there is a clear account of the early history of the subject and of the pioneers of the last and earlier generations, there is no reference in footnote or appendix to any of the current literature in the English (or American) language on Time Study, Motion Study, and other kindred subjects. It is a pity that the very useful short bibliographies in the original B.I.M. pamphlets have been omitted from this volume. The effect is to tend to restrict the book to use as a students' text-book, when it might have laid claim to a position as a standard work. As it is, teachers and advanced students will be obliged to go elsewhere to find their sources and even their standard works. Perhaps the most obvious example of this limitation is the otherwise admirable chapter on Activity Sampling which builds on the pioneer work of L. C. Tippetts without any mention of his name or of his original phrase "ratio delay."

In general, the whole canvas of work study techniques and applications is covered but there are one or two omissions. On the subject of financial incentives only one kind of payment by results is described and there is nothing to guide the student through the contemporary maze of theories and schemes. No attempt is made to evaluate the effect of payment by results in differing circumstances. Predetermined motion time systems appear briefly as P.M.T.S. in the index, with one reference to page 152. No definition or explanation is given there or elsewhere of the term or its origins. There is, throughout the book, a tendency to imply that work study in any recognisable form, began in 1947 or perhaps during World War II. This is, no doubt, the result of the change in terminology which Mr. Currie himself has sponsored, but it is interesting to remember that Professor Barnes' famous book, *Motion and Time Study* (now in its fourth edition), from which nearly two generations of British work study officers have learnt their craft, was first published in 1937, and even then contained a mass of data and experience built up over the previous decade.

Taken as a whole, however, *Work Study* can be recommended as a straightforward exposition of the subject. The basic techniques are set out clearly and in logical relation to one another and there is a good, simple index.

Mécanisme de la Déviation des Jets Propulsifs. By M. KADOSCH. Publications Scientifiques et Techniques du Ministère de l'Air, No. B.S.T. 124. Paris: Magasin C.T.O.: 2, Avenue de la Porte-d'Issy, Paris (15e). Price Fr.43.

THE object of the present book is to obtain a general synthesis of theoretical and experimental work carried out by S.N.E.C.M.A. on the deflection of jets for the purpose of thrust reversal of direction control. A historical account of progress in these two spheres is followed by a detailed description of different designs and their manner of functioning. In a theoretical study of the deflection of a two-dimensional flow by an obstacle or a second jet, the various parameters are investigated which enter into the equations (incompressible or compressible flow, size of gap, influence of walls, &c.). These findings are then applied to typical actual designs. The final chapter deals with the case where the deflection is obtained by adherence to a boundary surface.

Berechnen und Entwerfen der Schweisskonstruktionen. By P. SCHIMPKE, H. A. HORN and J. RUGE. Berlin-Göttingen-Heidelberg. Springer-Verlag: Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.33.60.

"CALCULATION AND DESIGN OF WELDED STRUCTURES" constitutes the third volume of the *Practical Welding Compendium* which first appeared in 1952. The present revised edition, like its predecessor, is intended as a guide for the welding engineer as well as the production engineer and general designer, and contains all relevant methods of design calculations, which are illustrated by a great number of actual welded designs from the field of general engineering, electrical engineering, pipeline and container design, and the design of vehicles, bridges, ships, structural steel frames, and cranes. The classified lists of weld seams and welded elements, as well as the wealth of illustrations (over 800) make the book a valuable work of reference.

Books Received

B.B.C. Handbook, 1960. British Broadcasting Corporation, Broadcasting House, London, W.C.2. Price 6s.

Marine Lubrication. By G. H. Clark. Scientific Publications (Great Britain), Ltd., 71, Great Russell Street, London, W.C.1. Price 100s.

Chemical Engineering Materials. Second edition. By Frank Rumford. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 32s. 6d.

Applied Petroleum Reservoir Engineering. By B. C. Craft and M. F. Hawkins, Jr. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 62s. 6d.

Asbestos, Its Origin, Production and Utilization. Second edition. By W. E. Sinclair. Mining Publications, Ltd., Salisbury House, London, E.C.2. Price 60s.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

B.22 BAYONET CAP LAMPHOLDERS OF MOULDED INSULATING MATERIAL

Supplement No. 1 (1959) to B.S. 52 : 1952 (PD 3559). Price 5s. This supplement has been prepared to provide a degree of interchangeability, in particular for shade carrier rings, which is not obtained with some of the existing lampholders which are on the market. It specifies the principal dimensions of a limited range of Type B.22 two-slot lampholders and protective shields intended for use in circuits of which the declared voltage does not exceed 250V in conditions under which the temperature of the lampholder does not exceed 135 deg. Cent. (275 deg. Fah.). The range covered comprises cord-grip, threaded dome and backplate lampholders.

It is well known that moulded insulated lampholders are subject to some shrinkage as a result of heating during service, and this shrinkage is not constant with any one design. The dimensions and tolerances for screw threads specified in this supplement result from a comprehensive programme of tests and will provide for variations in manufacture and for dimensional changes during the life of the shade carrier ring. Another object of the supplement is to include suitable tests to ensure satisfactory quality of design and manufacture. (B.S. 52 is mainly a dimensional standard and it has frequently been suggested that tests are desirable to discourage production of insulated lampholders of inferior quality.) Since the new designs are a radical departure from many existing designs, their production will call for major changes in manufacture, including the replacement of moulding tools. To allow time for the necessary changes to be made, the new supplement will not come into force until at least two years after the date of publication.

SPEEDOMETERS AND ODOMETERS FOR ROAD VEHICLES

No. 3190 : 1960. Price 2s. This standard covers instruments for two classes of road vehicles only, viz. light commercial vehicles and motor-cars, and heavy commercial vehicles ; not only the instruments, but the requirements and tests are specified to differ. In Part I, light vehicles, only mechanical speedometers are covered ; two gear ratios are envisaged, 1000 revolutions per indicated mile and per indicated kilometre, and also two grades of accuracy, $-0+5$ per cent and $+2+7$ per cent. (Tolerances on performance are unilateral throughout the specification, so that the possibility of an accurate instrument being supplied is reduced to a minimum.) Compliance may be claimed with only two points on the calibration curve within these tolerances. In Part II, heavy vehicles, gearings of 1000 revolutions per mile and 800 revolutions per mile (500 revolutions per kilometre) are specified ; there are also defined two kinds of enclosure, weatherproof and waterproof. Recommendations on style and sense of presentation apply to this part only, as do routine tests for index stability and type tests for endurance. Joints in drives are covered in an appendix ; one is interchangeable with S.A.E. Recommended Practice, 1955, while most of the remainder employ Whitworth thread forms and are sufficiently loosely defined for S.M.M.T. Standards 90, 91, 92, 103, 104A, and 106 to comply.

AMERICAN MACHINE SCREWS AND NUTS IN SIZES BELOW ¼IN DIAMETER

No. 3155 : 1960. Price 8s. 6d. This publication has been prepared because of the growing demand in the United Kingdom for machine screws and machine screw nuts complying with American National Standards. The British Standard follows the relevant passages of the American Standard (ASA. B 186. 3) closely, but not all types of screws and nuts specified in the latter have been selected for U.K. production. The new standard includes particulars of threads from the revised draft American Standard ASA. Bl. 1, and also gives details of suitable marking, which is not laid down in the American specification.

DIMENSIONS OF HOSE CONNECTIONS FOR WELDING AND CUTTING EQUIPMENT

No. 1389 : 1960. Price 4s. This revised publication extends the range of thread sizes to cover the following in the BSP.F. series : ⅛in, ¼in, ⅜in, ½in and ¾in. It follows the long-established practice of using left-hand threads and notched hexagons for combustible gases and right-hand threads and plain (un-notched) hexagons for non-combustible gases.

Although not a requirement of this standard, attention is drawn to the desirability of fitting safety devices to hose connections for protection against the effects of flash-back.

Electric Arc Steel-Making

At the annual meeting of the Iron and Steel Institute, on Thursday of last week, a paper on the new electric arc melting shop at the Steel, Peech and Tozer works was presented by Mr. A. Jackson and Mr. R. S. Howes.* The replacement of the existing open-hearth furnaces by electric arc furnaces was announced recently. The paper, extracts from which are printed here, explains the reasons for deciding upon electric furnaces and surveys the equipment to be installed in the new shop.*

DUE in part to the age of the Steel, Peech and Tozer plant at Templeborough, and the increasing efficiency of competitive steel-making processes, it became necessary to consider how the twenty-one cold-charged furnaces could be replaced by more economic operating units. The raw materials and general operating characteristics for a steel quality group which covers a large percentage of the total ingot production are shown in the second column of the accompanying table. In this same context it is important to note the comparable factors in the steel-making at Appleby-Frodingham (some 45 miles away) because this had an important bearing on the problem under consideration. It should also be noted that the overall usage of steel-making metallic raw materials in these two plants must continue in the same ratio in total, i.e. a change in the usage in one plant would call for an opposite change in the other.

Comparison of Steel-Making Methods

	Present practice		Future practice	
	Appleby-Frodingham melting shops standard o.h.	S.P.T. cold charged open hearth	Ajax process	S.P.T. electric arc furnaces
Mixer metal (cwt/ton ingots)	14·95	Nil	21·2	Nil
Cold pig (cwt/ton ingots)	Nil	8·40	Nil	Nil
Scrap (cwt/ton ingots)	5·70	13·95	Nil	21·42
Finishings (cwt/ton ingots)	0·205	0·18	0·21	0·16
Pit scrap (cwt/ton ingots)	0·87	0·80	0·75	0·54
Ore (cwt/ton ingots)	2·24	0·54	1·73	0·18
Slag made	2·42	4·25	3·00	1·53
Limestone (cwt/ton ingots)	1·25	Nil	1·00	Nil
Lime (cwt/ton ingots)	0·12	1·67	0·52	0·76
Fluorspar (cwt/ton ingots)	Nil	0·19	Nil	0·14
Dolomite (cwt/ton ingots)	0·67	0·76	0·58	0·20
Fuel (therms)	45·6	60·0	9·0	Nil
Oxygen-lancing (cubic feet)	Nil	Nil	1260	150
Oxygen-combustion (cubic feet)	103	Nil	150	Nil
Power (units)	—	—	—	525
Electrode (lb)	—	—	—	9·5
Tons/hour	15·7	8·9	29·0	29·5
Tons/furnace week	2640	1495	4875	4950
Availability, per cent	89·8	85·5	91·0	94·5
Brick consumption :				
Silica (lb)	26·14	44·8	1·24	10·0
Firebrick (lb)	3·27	24·6	1·33	—
Magnesite (lb)	2·08	0·2	0·95	10·5
Chrome-magnesite (lb)	5·88	13·1	13·52	—
Total	37·37	82·7	17·04	20·5
Tapping capacity (tons)	300	110	200	110

	C	P	Mn	S	Si
Iron analysis (cold pig)	3·65	1·35	0·90	0·050	0·65
Mixer metal analysis	3·4	1·15	0·40	0·045	0·25

Various possible solutions to the problem of replacing Steel, Peech and Tozer's melting shops were considered and rejected. These included installing plant to make the ingots in Scunthorpe by oxygen blowing processes, or supplying molten iron to Sheffield, but, finally, electric furnaces installed in Sheffield appeared most likely to give an economic replacement. The obvious plan was to consider melting the open-hearth mixture already in use, in large arc furnaces, and removing the carbon by oxygen lancing. Careful investigation showed that such a process could give some savings over the existing cold charged open-hearth practice. If, however, one considered the improvements possible in the existing plant, such as the application of basic roofs, oxygen for combustion, multiple burners and other things, then the prospective savings were so reduced that it was most difficult to see a satisfactory return on the new capital it would be necessary to expend to replace plant already largely written off.

At this time Appleby-Frodingham was beginning to obtain results on the "Ajax"† oxygen steel-making process, which was proving to be more efficient, using 100 per cent molten metal, than the traditional process using 76 per cent molten metal and normal circulating scrap. As soon as this process was proved to a reasonable degree, it brought forward a significant new possibility, i.e. to send Appleby-Frodingham circulating scrap to Sheffield instead of cold pig iron, so that the electric furnaces could operate close to 100 per cent scrap. This obviously reduced slag volume and the necessity for its removal with such increase in production rate that the projected seven-furnace plant could be reduced to six furnaces. The revised raw materials distribution can be seen by reference to the table. Column 1 shows the former standard open-hearth practice at Appleby-Frodingham Steel Company, which gave best results, either more or less scrap decreasing output progressively from this optimum.

The "Ajax" process figures are shown in the same table (column 3) and are based on the last 200,000 tons of ingots produced. They show a considerable improvement on the early "Ajax" practice as already published.‡ The arc furnace figures (column 4) are derived from work on Steel, Peech and Tozer small arc furnace and from published information, but they were confirmed as fully as possible by operating an 80-ton arc furnace at the Samuel Fox works for a month, using the proposed Steel, Peech and Tozer mixtures and making the types of steel that company expects to require.

* The United Steel Companies, Ltd.

† *Journal of the Iron and Steel Institute*, September, 1958.

‡ *Journal of the Iron and Steel Institute*, May, 1959.

Comparison of Steel-Making Methods

In order to make a comparison between former practice, using open-hearth furnaces in both Appleby-Frodingham and Steel, Peech and Tozer melting shops, with the proposals to use the "Ajax" process at the former and electric arc at the latter, the following figures are used : (1) Out of the ingots produced by the two plants together, about 58 per cent has been produced at Appleby-Frodingham and 42 per cent at Steel, Peech and Tozer, and it is expected that this ratio will remain about constant ; (2) 100 per cent molten iron in the "Ajax" process and 100 per cent scrap in the arc furnace (although a small degree of interchange is practicable). The figures show that the use of open-hearth furnaces at both plants requires in total, 61 per cent of pig iron, whilst the new method requires 61·5 per cent. The ingot yield calculated on charged pig iron, scrap and Fe from ore is 88·54 per cent and 89·46 per cent respectively, a gain of 0·92 per cent. If the costs of fuel, oxygen for lancing and combustion, electrodes and power (arc furnaces only) are compared, there is no significant difference between past practice and the new practice, taking the two plants together in each example.

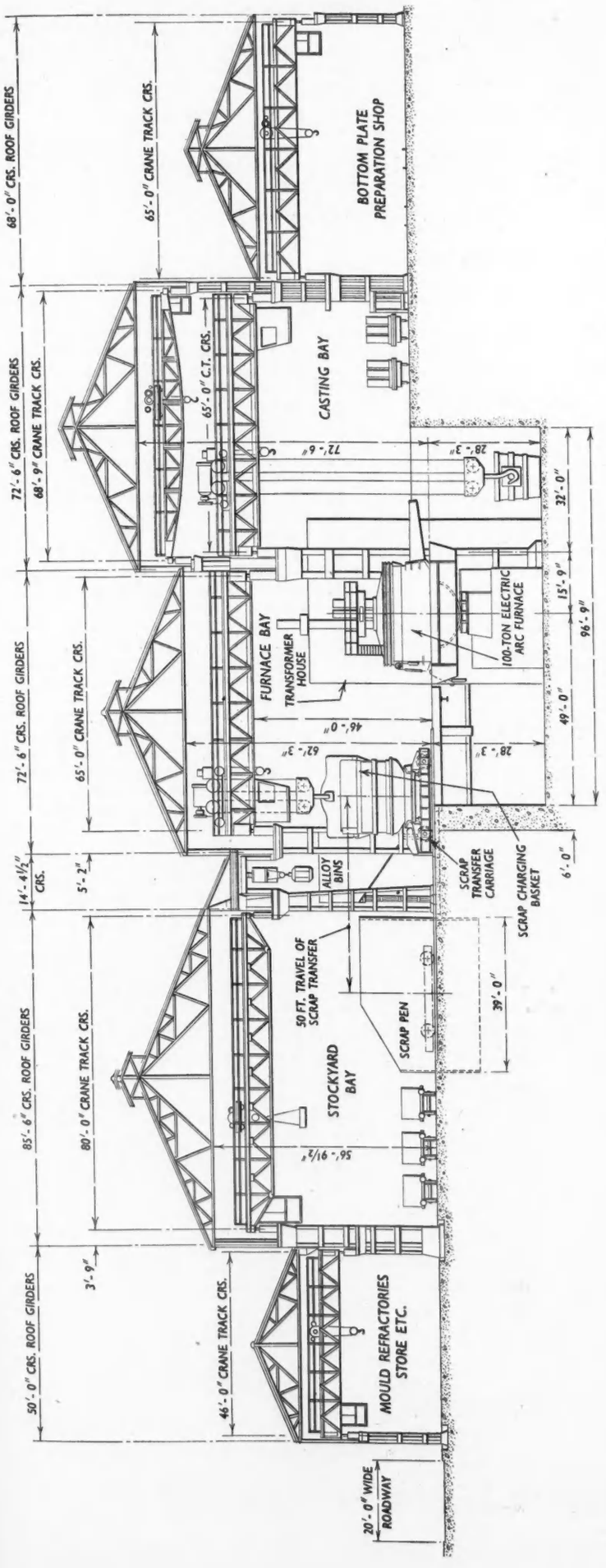
The production per operating furnace has increased by over 80 per cent, using the "Ajax" process, and by 350 per cent from the new arc furnaces, thereby giving material reduction in working costs. Refractory brick consumption and fettling dolomite show marked reduction in costs. The total lime consumption and slag volume produced have fallen. More slag is, however, made in the "Ajax" furnaces and it contains a higher phosphoric acid content than formerly. This arises because the phosphorus which was formerly sent to Steel, Peech and Tozer and discarded with the slag, is now retained at Appleby-Frodingham and sold as fertiliser.

By changing from open-hearth steel-making from hot metal in large tilting furnaces and cold-charged fixed furnaces to the "Ajax" process, using hot metal and the arc furnace using cold scrap, significant cost savings can be made. As the same ratio of scrap and pig iron in the raw materials used is retained, it is unnecessary to include the relative prices of scrap and pig iron (which often make comparisons so difficult) in assessing the total proposals for the two steel-making plants closely concerned.

Templeborough Electric Melting Shop

When conversion plans are complete, the Steel, Peech and Tozer plant will consist of six 24ft diameter electric arc furnaces, each tapping 110 ingot tons. Each furnace will be powered by a 40,000kVA transformer and fitted with 24in diameter graphite electrodes. A cross-section through the plant is reproduced herewith. The site at the present time is occupied by Templeborough melting shop which produces 900,000 ingot tons per annum out of fourteen fixed cold metal open-hearth furnaces. As the new shop is designed to produce over 1,350,000 ingot tons per annum, considerable modification has had to be made to the raw material handling facilities, the casting pit and stripping area, as well as the furnace bay. The following notes give a brief description of each section of the shop :

Layout of Railways.—In order to handle the greatly increased amount of scrap that



Cross section through proposed Templeborough electric melting shop

will be required by this melting shop, a very extensive marshalling yard has been laid out behind the raw material stockyard. This marshalling yard has sufficient capacity to store twenty-four hours' supply of raw materials, and consists of reception sidings, holding sidings with adequate roads for shunting operations, sidings for empty wagons and wagon weigh facilities. Extensive alterations have also been made to the casting pit and mould shop railways to ensure adequate disposal of ingots to the mill. It is intended to dispose of slag by road transport instead of the present rail slag pot system, and road access has had to be improved accordingly.

Raw Material Stockyard.—The problem of filling electric furnace baskets is very different and in some ways much simpler than filling open-hearth charging pans. The stockyard has been arranged with nine basket-filling stations, each served by its own magnet crane. These stations are arranged in groups of three, each group being served by its own railway line and containing scrap pens as well as wagon standing room. These scrap pens have a capacity of 24,000 tons and are intended to smooth out fluctuations in the flow of incoming raw materials and to provide against interruptions due to bad weather, &c. Between the stockyard bay and the furnace bay there exists a narrow building that at present houses the open-hearth furnace chimneys. Advantage is being taken of this small bay to provide storage bunkers for oxides, fluxes and fettling materials, storage bunkers being filled by an overhead monorail crane. At the eastern end of the stockyard bay a special area has been set aside for a ferro-alloy store. This will contain storage pens, barrel stocking racks and drying facilities for removing moisture from the alloys.

The Furnace Bay.—The open-hearth stage has to be completely removed and the arc furnaces will be installed at ground level, with a transformer house between each pair of furnaces. The columns lining each side of the furnace bay will require extensive modification in order to withstand the increased loading of the three new basket-charging cranes of 150 tons capacity each. At the same time, modification to the roof of this part of the building will be necessary to give the required crane clearance. Slag removal from the furnace will be arranged in an underground tunnel, by road vehicle, emerging at the western end of the shop. The present open-hearth stage is nearly a quarter of a mile long. The arc furnaces and ancillary equipment only take up little more than half the length of this building ; it is proposed to convert the east end of the shop into a new mould storage and stripping bay to deal with the additional tonnage. In this section of the shop two stripper cranes are to be installed. Roof bricking and storage will take place at either end of the furnace bay. Refractory materials for both roof and furnace construction will be supplied by underground tunnel to prevent interference with the shop cranes.

The Casting Pit.—Very little alteration is made to the existing casting pit apart from some reorganisation of the railways and mould cooling gantries. The present casting cranes, of which there are four of 150 tons capacity, will be adequate for the electric shop, but these cranes will need fitting with new rope drums in order to get the extra length of rope required to reach down into the arc furnace ladle pits. At the west end of the shop, special arrangements will be made for producing forging ingots from 3 tons to 100 tons each in weight, both by

conventional and vacuum casting. At the Rotherham end of the casting pit slow cooling facilities are provided for alloy and other crack-susceptible steels.

The Mould Shop.—The existing mould shop is almost at the limit of its capacity. Here a completely new building, 75ft wide and 600ft long, is being erected for the processing of casting cars, and all preparatory work for the casting pit will be done in this area, casting cars being processed on a line assembly basis. Refractory hollow ware will be fed to this shop by tunnel from the central brick stores.

Power Supply.—The furnaces will be fed from the 275kV grid, which will be brought to a new sub-station on the south of Sheffield Road. This sub-station will consist of four 75MVA transformers which step down to 33kV, supplying the arc furnace busbar. The 33kV supply is then taken direct to the furnace transformers crossing Sheffield Road by a tunnel.

Ancillary Buildings.—The main office block and control centre for the melting shop is situated to the south of Sheffield Road, and access is provided between this building and each bay of the melting shop by tunnel. This building will also contain an amenity centre, canteen and time office. A new chemical laboratory is being built in the works and each furnace will be connected directly by a high-speed large-bore rabesi tube, with direct communication between laboratory and furnace cabin, bath sample analysis being done by spectrographic means.

Shop Production.—The bulk of the shop production is plain carbon and rimming steels for billet, bar, rod and strip mills, but smaller tonnages, have also to be provided for wheel and tyre mills and the press and hammer forges.

Steel-Making.—The bulk of the steel qualities will be made, using a single slag technique, and ladle finishings, from a charge consisting of 100 per cent scrap with sufficient anthracite to give a 0·40 per cent carbon boil. To achieve the stated output, it will be necessary to receive 30,000 tons of scrap per week—7500 tons of this will come from the works' own arisings and 10,000 tons per week from Appleby-Frodingham, the remainder being bought merchant scrap. For the alloy qualities at present made by the acid open-hearth process, and for steels of conventional electric quality, a short reducing slag period will probably be necessary, giving a double slag practice. In those cases, where low gas content is important, it may well prove advisable to revert to a bath or even ladle finishing. For extreme cases, and certainly with the heavy forging ingots, vacuum casting presents a proven means of producing low hydrogen steels.

In column four of the table details are given of the furnace performance figures that are expected. These are mainly self-explanatory, but it is perhaps worth noting that the average output rate is given as 29·5 tons per hour. This is a composite figure based on the qualities it is expected to make. For the bulk of the production, 33½ tons per hour is anticipated, i.e. a furnace cycle time of three hours twenty minutes, tap to tap. With the exception of forging ingots, which will be floor-cast in sunken pits at the west end of the shop, the entire production will be car cast, the majority being uphill teemed.

Fume Cleaning.—In order to meet the requirements of the new clean air legislation, the furnaces will be equipped with extensive fume cleaning plant. Although the design of this has not yet been finalised, it will probably consist of direct extraction through the furnace roof, a spray conditioning chamber and electrostatic precipitators.

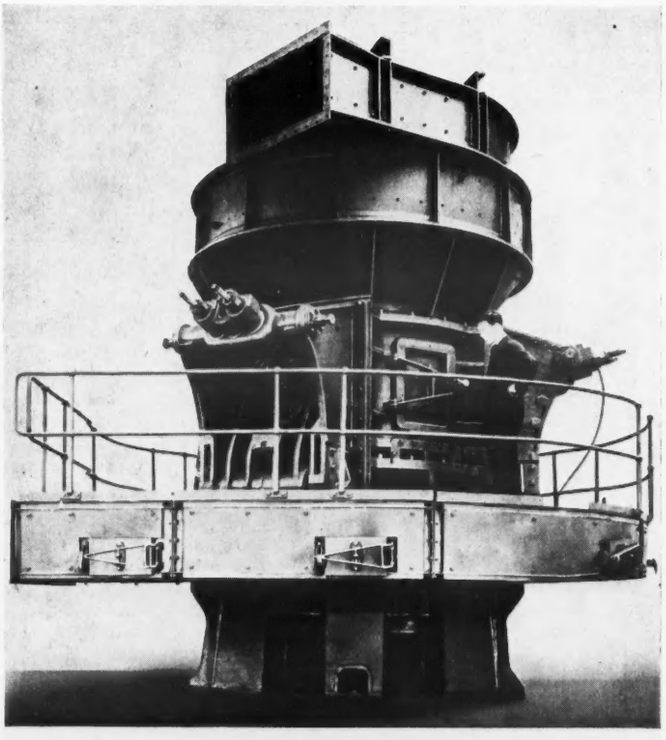
Rubbish Disposal.—To keep the cross traffic in the melting shop down to a minimum, the furnace cellars have been enlarged and a system of cross tunnels will be incorporated, so that all rubbish arising from furnace dismantling, the casting pit and mould shop can be removed by road transport running underground.

Fuel Efficiency Exhibition

No. II—(*Concluded from page* 786, *May* 6)

WE conclude here our account of the Fuel Efficiency Power for Industry Exhibition which was held at Olympia, London, from Wednesday, April 27, to Friday, May 6. Among the items seen on the stand of W. C. Holmes and Co., Ltd., was a model of the company's Holmes-Retroflux bag filter. This filter, which operates on the continuous method of cleaning, is claimed to have an efficiency in excess of 99 per cent for all particles below 5 microns. Dust-laden air is distributed from the header within the casing to the inside of the bags, the air passing through the bags radially and its velocity diminishing to zero at the bottom. The dust collected on the inner surface of the bags is continuously dislodged by the passage of high velocity air jets through the fabric in the reverse direction to the main air stream, thus dispensing with the need for rapping or shaking mechanism. The jet tubes are mounted in pairs, one set being arranged 3in below the other and set at 90 deg. to the other, so that cleaning is progressive. Hollow frames, suspended by chains, carry the jet tubes and operate in counterbalanced pairs and pass over the length of the bags. Also shown was a model of a liquefied petroleum gas plant consisting of storage tanks, vaporisers, mixing unit and ancillary equipment.

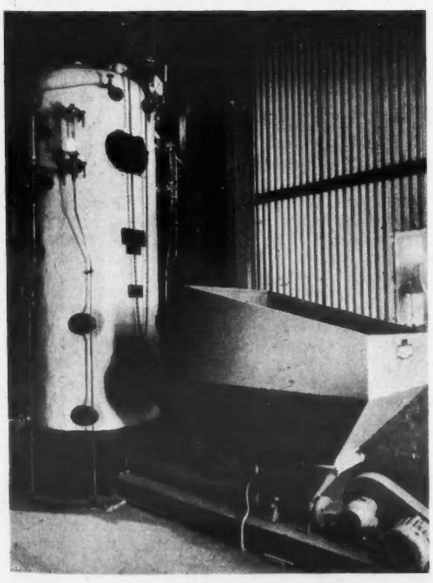
The dominant exhibit shown by International Combustion, Ltd., was the Lopulco three-roller mill seen in our illustration. This mill is one of thirty to be installed at the High Marnham power station and has been developed to meet the high capacity demand of the station; five mills will be mounted with each of the five 200MW International Combustion boiler units. A total of 28 tons of coal with a 10 per cent moisture content, or 23·7 tons of coal with a 21 per cent moisture content, can be ground per hour by the mill and the coal is delivered to the mill via a vertical central tube on to the steel mill table which has a segmental renewable grinding ring. A 300 b.h.p. electric motor having a speed of 1480 r.p.m. drives the mill table through gearing consisting of a spiral bevel on input shaft to single helical spur gear on the output shaft, the gear ratio being 28·5 to 1. The spring-loaded grinding rollers are of a special cast iron and the roller arm assemblies can easily be withdrawn to permit renewal of the rollers. The spring tension is 31,000 lb, giving a load of 62,000 lb on the roll. Air is delivered to the mill at 34,300 to 36,000 cubic feet per minute with variation of moisture content in the fuel from 8 to 21 per cent, and its temperature varies from 474 deg. to 540 deg. Fah. The pulverised coal is carried upwards to pass through two vane wheels, driven by a variable speed motor, which act as separators and control the size of the coal particle, the larger particles being thrown outwards to return to the mill table. The pulverised coal and air mixture leaves the mill at a temperature ranging from 136 deg. to 190 deg. Fah. and passes to exhauster fans for delivery to the burners. Also shown was the I.C. viscometer for use in oil-burning systems, &c. This instrument is designed for a maximum working pressure of 600 lb per square inch gauge and is located in the high-pressure service line from which it bleeds a small amount of liquid to a lower pressure line. A valve keeps the pressure across the instrument at about 40 lb per square inch gauge for oil-burning systems. The liquid passes through a turbulent flow orifice and then through a laminar flow orifice and a differential pressure gauge records the pressure difference, to which the kinematic viscosity is related for a fixed value of specific gravity. No correction is needed for the specific gravity of the oil since fuel oils when heated to the same viscosity have practically the same specific gravity.



"Lopulco" three-roller mill to handle 28 tons of coal per hour—International Combustion

British Boiler Accessories, Ltd., had on view a sealed unit heat exchanger which is a development from the company's helical tube range of heat exchangers. These units have a shell of all-welded or brazed construction with simple end boxes with the helical tubes mounted between fixed tube end plates, the claim being made that even with vibration and rapid changes of temperature and pressure, no damage can occur. The "Heliseal" is manufactured having a heating surface ranging from 1 to 38 square feet and is suitable for most liquid to liquid and steam to liquid heat transfer applications. An "Elstac" electric steam accumulator boiler was shown which is able to meet peak steam demands in excess of the steam rating associated with the electrical input. The boilers have an average steam output ranging from 30 lb to 240 lb per hour, associated with electric loading ranging from 9kW to 72kW, and have been designed for two pressures, namely, 150 lb and 250 lb per square inch. They are intended to meet the requirements of small steam process users requiring a sudden burst of steam for short periods with only a small quantity during the rest of the cycle. This is achieved by storing the steam which can be discharged at a high rate.

We illustrate herewith a vertical industrial boiler built by Redheugh De Poray Boilers, Ltd. The boiler, which is suitable for oil or solid fuel firing, has two furnaces, the first being the primary combustion chamber with expansion element and the second the diffuser which is lined with refractories. This secondary combustion chamber ensures complete and smokeless combustion with the minimum of excess air. Here the high temperature of the diffuser chamber speeds up combustion reaction and increases the velocity of the gases which enter the radiation bell from which they pass over

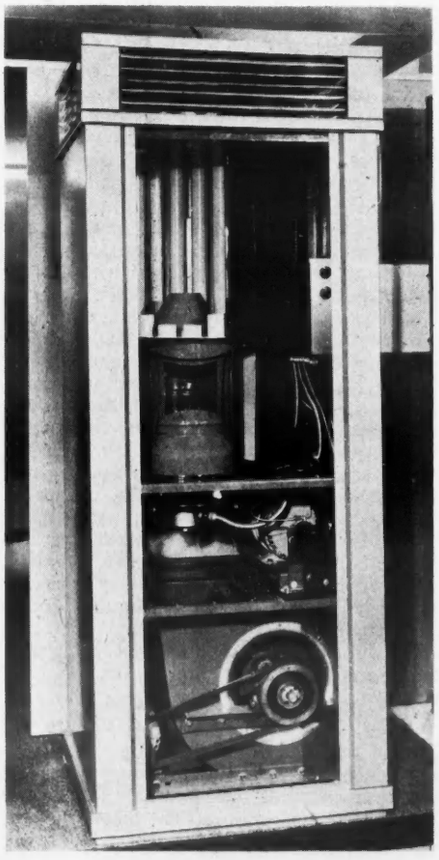


De Poray vertical water-tube boiler—Redheugh De Poray Boilers

the Field tubes containing central circulation tubes. These tubes are placed in the chamber above the diffuser and are thus heated by indirect radiation from the radiation bell and convection by the returning gases from the bell. The arrangement gives increased transmission of heat uniformly over the tube surface, while the central circulating tubes allow the cooler water to flow down without coming into contact with the steam product.

The development of the application of oxygen to the process of making steel has brought in its wake consequential problems, one of which is that of fume emission. For the already considerable discharge of fume has been aggravated by oxygen lancing and blowing. To deal with this problem Simon-Carves, Ltd., developed an electro-precipitator for the collection for fume and fine dust particles which in the steel industry average from 50 to 60 per cent smaller than 1 micron. A cut-away model of an electro-precipitator was exhibited together with a diagrammatic animated panel showing the basic principles. Gases enter the precipitator at below 250 deg. Cent., and dust is collected in the dry condition, there being no necessity for water or steam injection to improve precipitation conditions. The receiving electrodes are assembled in panels from individual channels, separately suspended and with sufficient resilience to transmit transverse rapping vibrations over their entire area.

Colt Ventilation, Ltd., had on exhibition examples of its range of industrial oil-fired air heaters, of which there are three sizes, the "TS 500," "TS 350" and the "TS 250," and of which the 500,000 B.Th.U. per hour unit was under fire during the period of the exhibition. A cut-away view of a heater is shown in our illustration. In the

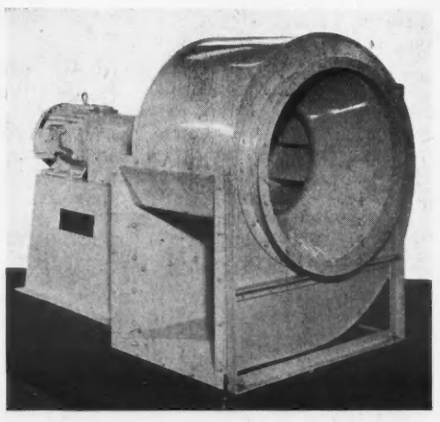


Cutaway view of turbo-static oil-fired air heater—Colt Ventilation

Colt combustion unit the air requirement for the complete combustion of 1 lb of gas oil is 16 lb. A pressure blower forces air into the combustion chamber through a series of vaned slots in the inner chamber wall. These vanes impart a swirl to the air creating two contra-rotating streams. Interaction between the air streams causes turbulence and the complete and rapid mixing of oil mist and air to reduce excess air requirements to a minimum. Furthermore the vortices ensure complete combustion in a limited space while the outer stream of air forms a barrier which prevents the flame from impinging on the chamber walls. Two outer walls insulate the combustion chamber from the main air supply so that conduction heat loss is a minimum and the combustion air is preheated to above the evaporation temperature of the oil mist so that combustion is instantaneous.

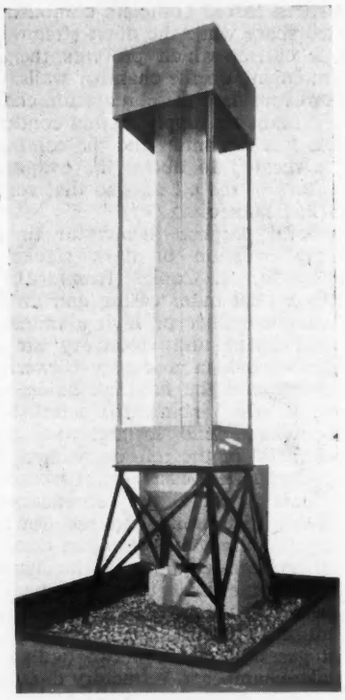
A general purpose incinerator to overcome the emission of dark smoke was shown by W. H. Cooke (Romford), Ltd. This has a steel outer casing and an inner combustion chamber of high alumina firebricks. Primary and secondary air flues are incorporated in a cavity between the outer casing and the firebrick lining. The interior of the incinerator consists of firing, downtake and scaling, and uptake chambers, and in the refractory-lined firing chamber are fitted cast iron firebars and bearer bars; there are secondary air ports in the side walls. In the downtake chamber is a removable cast iron door and between the downtake and uptake chambers is a honeycomb wall through which the gases pass, and which is brought to a high temperature to ensure combustion of any unburnt gases. There are two dampers in the uptake chamber, a refractory damper to control the flue draught and a cast iron damper having staggered holes through which the exhaust gases pass. This retards the upcast, collects soot and flue dust and acts as a spark arrester.

Fans for mechanical draught, with or without vane control, for mechanical stoker and oil-fired boilers formed part of the exhibits shown by the Sturtevant Engineering Company, Ltd. These included a backward-sloped aerofoil bladed B.A.V.A. fan having a casing of raised seam construction and impellers having ten aerofoil section pressed blades with a shroud on the inlet side and a pressed dished backplate on the driving side mounted on the hub which is keyed to the shaft. A size No. 8 fan, illustrated herewith, was on view and is rated at 8500 cubic feet per minute at 5in water gauge with air at 60 deg. Fah., driven at



B.A.V.A. fan—Sturtevant Engineering

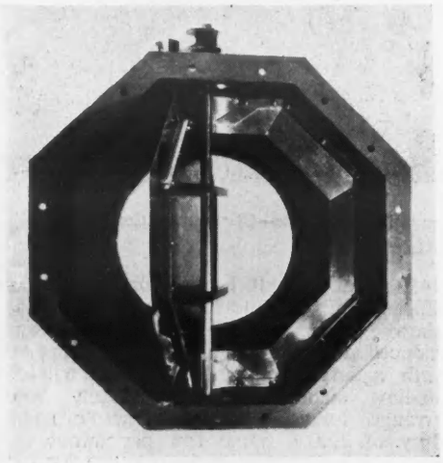
1450 r.p.m. by a 10 h.p. motor, and has an efficiency of between 89 to 92 per cent. Also shown was a No. 8 M.V.A.Z. multivane induced draught fan having an impeller with a large number of forward curved shallow blades, air-cooled bearings and arranged for vee-belt drive. This fan has a duty of 12,000 cubic feet per minute at 2·85in water gauge with gas at a temperature of 450 deg. Fah. and driven at 940 r.p.m. by a 10 h.p. motor. An example of the



High temperature textile filter—Sturtevant

latest design of electrostatic precipitators for the cleaning of boiler flue gases was exhibited and can be seen in our illustration. In this unit rapping and bag shaking are eliminated, and the material used is specially treated to give it qualities which enable it to be used in the temperature range 450 deg. to 550 deg. Fah., and even as high as 800 deg. Fah. under certain conditions. Since the material can be used at temperatures above dew point, corrosion troubles associated with condensation are eliminated. As already mentioned, shaking and rapping gear are not required since the material discourages the adhesion of dust, and a simple periodic collapse of the bags is adequate to dislodge the dust into the hoppers. This same property of non-adhesion ensures a constant and low resistance to gas flow.

On its stand, the Metropolitan Engineering Company, Ltd., demonstrated its "Metro-Flex" thermal storage system which is designed to overcome the emission of smoke and smuts and the corrosion of metal ducts when the heat input of an oil-fired boiler is reduced during periods of low or fluctuating load running. These are the results of low exit temperatures and can be avoided by the heat-resisting, leaf spring sealing system which ensures gas-tight sealing of the flues when the steam demand drops and the burners cut out. With the flues sealed off by the "Metro-Flex" equipment, illustrated herewith, the boiler is converted into a thermal storage unit and no cold air is drawn through, to lower back-end and chimney temperatures, and since the boiler remains hot it is not exposed to thermal shock.



"Metro-Flex" thermal storage system—Metropolitan Engineering

Among the fan and blower exhibits seen on the stand of Keith Blackman, Ltd., was a working model of a shot cleaning system for the cleaning of heat convection surfaces in boilers, superheaters, economisers, &c. The Keith Blackman-Broman Ekström system utilises shot to strike the heating surfaces and break loose the deposits. By means of spreaders, the shot is distributed evenly over the cross-sectional area of the heat exchanger at a rate of fifteen to twenty-five shots per second on each square foot of surface. In falling under gravity, the shot ricochets from tube to tube and, after cascading through the heat exchanger, is collected at the bottom and returned to the spreaders by a pneumatic system. The cleaning system can be operated without alteration in load and, being dry, does not affect the dew point of the gases.

A full range of oil-firing equipment was displayed on the combined stand of Hubbard Combustion, Ltd., and The Wallsend Slipway and Engineering Company, Ltd. There were pressure jet, steam jet and medium pressure air systems, together with the Wallsend-Hubbard low-pressure air system which can be arranged for hand, semi-automatic or fully automatic control. Also included was a Ray horizontal spinning cup oil burner. In this burner a primary pump draws oil from storage through a hollow hinge and delivers it to a reservoir, from which a submerged secondary pump provides a constant supply of oil to the Ray viscosity valve. This passes a metered quantity to the burner, the remainder being returned to the reservoir, while excess oil from the primary pump returns to storage. The oil, as metered by the viscosity valve, passes through the stationary central tube which passes the motor-driven main shaft of the burner to the tapered rotating atomising cup. Here the oil is thrown from the sharp conical rim of the cup in a counter clockwise direction and, provided by a centrifugal fan, primary air, given clockwise rotation and directed through a passage surrounding the cup, breaks up the oil into an extremely fine mist which ensures efficient combustion.

Technical Meetings

A series of technical meetings, under the general title, "The Selection of Fuel-Using Equipment and Power Plant," were convened by the Institute of Fuel and held during the period of the exhibition. The meetings were opened on Monday afternoon, May 2, by Dr. A. C. Monkhouse, president of the Institute of Fuel, and with Captain W. Gregson in the chair, D. C. Gunn presented his paper, "Effective Combustion in Steam Boilers." At the second session of the afternoon, Sir Josiah Eccles, D.Sc., was in the chair and a paper entitled "Efficient Use of Electricity in Industry," by W. J. Dickie, was read. On the afternoon of Tuesday, May 3, under the chairmanship of G. Richardson, R. F. Hayman read his paper, "Heat Transfer" and at the next session the following papers were presented: "Heat Losses," by J. H. G. Bilney, and "Heat Recovery," by F. H. Newman.

Technical Reports

Crack Propagation in Sheet Material—Some Conclusions Deduced from a Combination of Theory and Experiment. By D. Williams. A.R.C. Current Paper No. 467. H.M. Stationery Office. Price 4s. 6d.—The purpose of this note is to enable the crack propagation properties of sheet material to be determined in a much more economical way than has hitherto been possible. This objective is sought by establishing simple formulæ for correlating the results for small flat sheet specimens under tension or cylindrical specimens under internal pressure, with those for larger but similar specimens, and for correlating results for a flat sheet with those for the corresponding (i.e. the same flat sheet rolled into a cylinder) cylindrical sheet under the same tension produced by internal pressure.

Thermodynamic Data for the Calculation of Gas Turbine Performance. By D. Fielding and J. E. C. Topps. Reports and Memoranda No. 3099. H.M. Stationery Office. Price 45s.—The essential factors of a practical method of determining gas turbine performance are that it shall be suitable for accurate routine calculation, and that it is capable of simple modification in order to deal with a range of fuels or with complex cycles. It is the opinion of the authors that the exactitude of the method should also be demonstrable, within the limits imposed by the scales employed, and that it should require only the use of parameters physically intelligible to the average engineer, and a sequence of operations which can be followed by a computer. The calculation should not, moreover, be onerous, involving the use of large or complex charts, or interpolation in tables.

Experience has shown that cycle analysis is most efficiently carried out by numerical evaluation of the energy change involved in each stage of the process, so that corrections for plant efficiency and for losses due to friction, to imperfect combustion, to the use of air for cooling, &c., may be applied as they occur, and the data presented are selected with this in mind. The data required are therefore the total heat and entropy of gas mixtures, and the relations for the temperature rise on the combustion of fuel in air. The problem is to present such data compactly for a range of fuels, and the solution adopted is :

(*a*) The presentation of simple methods of calculating the properties of such mixtures and changes of temperature, so that users may prepare data for any fuel they wish, together with

(*b*) The properties and relations for a "standard" fuel of given composition and calorific value so that the performance of engines may be compared under definite conditions.

The method employed is the development of equations for the difference between a property of a gas mixture and the corresponding property of air.

Abnormal Loading on Composite Slab Bridges. By B. C. Best, B.Sc., and R. E. Rowe, M.A., A.M.I.C.E., Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1. (Free.) Tests on a series of composite slab bridges are described and the results analysed. The bridges incorporated precast prestressed inverted T-beams, *in situ* concrete of different qualities and mild steel transverse reinforcement of different amounts. Each of the bridges behaved satisfactorily under both the design and ultimate load conditions for abnormal loading ; the individual beams were designed on the basis of the Ministry of Transport's standard loading with the increase suggested by Holland and the transverse reinforcement was designed to provide an ultimate transverse moment which would ensure a satisfactory load factor when based upon a yield-line analysis.

In the bridges with transverse steel, the distribution properties for deflection were a maximum of 9 per cent poorer than those for a similar isotropic slab under abnormal loading ; for moments, it being noted that the theoretical coefficient must be increased by 10 per cent in this case, the distribution properties were poorer by less than 9 per cent. The general behaviour of each bridge even after repeated overloadings to 1·5×abnormal load was essentially stable and the recovery in every case was good.

At ultimate load, each bridge had a load factor for live load equal to, or greater than, 2·7 for the abnormal load placed in such a position as to cause the worst transverse bending moments ; it should be noted that, in addition to this load factor, the dead load was effective, i.e. the load factor on it was unity. It is estimated that, with the abnormal load in the position causing the maximum longitudinal moments, the load factor on live load would have been between 2·0 and 2·1 for the bridges with transverse steel. In every case the theoretical ultimate load derived from a yield-line analysis was in good agreement with the experimental results, as was the mode of failure.

The amount of transverse reinforcement required to give the load factors mentioned above was such as to give an ultimate sagging moment transversely of about 8·5 per cent of that longitudinally. This may be compared with an elastic transverse moment of about 41 per cent of the corresponding longitudinal moment.

British Railways Modernisation

IN a review of modernisation on British Railways issued by the British Transport Commission on May 9, it is stated that since the programme began in 1955 the number of steam locomotives has been reduced from 18,500 to a little more than 14,000. By 1961, the total number of steam locomotives will be less by about 7800, or 40 per cent, than in 1954 ; coaches will have been reduced by about 10,000, or 28 per cent, to some 32,000 ; and the total number of freight wagons will be about 960,000, that is less by 165,000, or 15 per cent, than when modernisation began.

New Motive Power

By the end of 1961 it is expected that diesel or electric power will have virtually replaced steam traction in East Anglia and in most of south-east England. Comparatively few steam locomotives will then be left on lines : (i) in the west of England (west of Newton Abbot) ; (ii) on the St. Pancras main line south of Bedford; and (iii) on the East Coast main line from King's Cross to the north. Steam locomotives will by then be used everywhere mainly for freight duties.

Work on nearly 200 more route-miles of high-voltage a.c. electrification should be completed in September or October this year. The routes concerned, comprising about 600 track-miles, are : Liverpool Street to Enfield, Chingford, Hertford and Bishop's Stortford ; Liverpool Street to Southend and Chelmsford (conversion from 1500V d.c.) ; Manchester to Crewe ; and Glasgow suburban area, phase 1 (serving Helensburgh, Milngavie, Glasgow Queen Street, and Airdrie). By the end of this year electrified lines will total 3544 track-miles and it is expected that electrification work will be at an advanced stage on another 280 route-miles (about 740 track-miles), all of which should be completed in 1961. This includes the line between Liverpool and Crewe, the second stage of the main-line electrification which will ultimately reach London (Euston) ; the London, Tilbury and Southend line, and the second phases of the Glasgow suburban and Southern Region Kent Coast electrifications.

There are now some 3400 vehicles in use in diesel multiple-unit train sets, and they will increase by the end of the year to about 4000, or almost as many as are at present planned. Over 500 main-line diesel locomotives of all kinds are in service and over 1300 are on order or authorised. It is expected that there will be about 900 in service by the end of the year and there may be 1200 in use by the middle of 1961. Deliveries this year will include twenty-two English Electric "Deltic" locomotives for the East Coast main line, where they will replace fifty-five steam locomotives. Diesel shunting locomotives now number 1400, and about 1750, nearly 90 per cent of the eventual fleet, should be in service by the end of 1961, when steam shunting in marshalling yards will virtually have disappeared.

A further development in diesel traction which will be introduced this year is the de-luxe diesel Pullman express. There will be five of these trains ; two of six cars for first-class passengers only, and three of eight cars with accommodation for both first and second-class passengers. The six-car trains will run between Manchester and London (St. Pancras), and Leicester and London (St. Pancras), and the eight-car trains between Bristol and London (Paddington), and Wolverhampton, Birmingham and London (Paddington).

Increases in Traffic

Freight traffic in the first fifteen weeks of this year totalled 75,700,000 tons, an increase over 1959 of 4,800,000 tons. Speeds of freight trains are steadily rising as more wagons are fitted with continuous brakes. About 300,000 wagons, nearly one-third of the total fleet, are now equipped, and all merchandise wagons should be fitted by the end of this year.

Better passenger services are also attracting more traffic. In the first six months' operations of the newly-electrified Kent Coast line, well over 1,050,000 more passengers were booked along the line, ticket sales increased by nearly one-third, and about 40 per cent more passengers arrived by rail in the area. Even larger increases in passenger journeys and receipts resulted when electric train services on the Liverpool Street-Shenfield line were extended first to Chelmsford, and then to Southend, in 1956. In the year ended December, 1958, passengers on these lines increased by 2,807,733 to 5,420,335, a rise of 107 per cent, and receipts were £575,624 higher at £1,068,047, an increase of 117 per cent compared with the last year of steam trains. In 1959 there was a further rise, and passengers totalled 5,913,369, or 3,300,767 more than they were with steam, and receipts rose by £718,811, or 146 per cent, to £1,211,234.

Substantial increases in passenger traffic have followed the introduction of diesel trains in almost every area. One of the biggest increases recorded followed the introduction of a diesel train service between Leeds and Barnsley in March, 1958. During the first full year of diesel operation on this route receipts rose by more than 400 per cent and over 740,000 passengers were carried, an increase of 263 per cent. These exceptional figures admittedly followed operation of the service by rolling stock of below average standard, but they illustrate the possibilities of regaining traffic with new equipment.

Among the longer diesel-operated routes, inter-city diesel train services began to run between Glasgow and Edinburgh in January, 1957. In the year ended December, 1957, passengers increased by 559,730, or 26 per cent, to 2,733,357, and receipts rose by £95,751, or 29 per cent, to a total of £429,759. Further increases in passengers and receipts took place during 1958, and in the year ended December, 1959, the total number of passengers was 3,091,064, an increase of 917,437, or 42 per cent when compared with steam services, and the total receipts were £153,148, or 46 per cent higher at £487,156.

Track and Signalling

At the end of 1959 long-welded rails (300ft lengths) had been laid on 200 miles of track. Another 240 track-miles of long rails will be laid this year, and by mid-1961 the output of long rails is expected to allow for 320 track-miles a year.

Another significant change which is taking place in the permanent way is in the use of concrete sleepers which will be more widely used, particularly in association with long-welded rails. At the end of last year some 1500 miles of track had been relaid with concrete sleepers, and another 300 track-miles will be installed this year. By mid-1961 the output of concrete sleepers will have reached an annual rate of about 650,000, sufficient for nearly 330 track-miles.

The plan to equip five main routes of British Railways with the automatic warning system by 1963 is accelerating. It was estimated when the installation programme began in 1958 that within five years about 1800 route-miles of railway and some 10,000 locomotives and trains would be fitted with the system. Already, more than one-third of this total route-mileage, and nearly one-fifth of the locomotives and trains, have been equipped. Main-line sections completed are Glasgow-Edinburgh (47 route-miles), Exeter-Salisbury (88 route-miles), King's Cross-Newcastle (275 route-miles), Edinburgh-Berwick (50 route-miles), and Euston-Stafford (133½ route-miles). Minor adjustments have enabled locomotives equipped with the British Railways standard apparatus to operate over the Hudd ground equipment on the Fenchurch Street to Southend line. This section will be equipped with the standard track apparatus when it is electrified in 1961.

Research

The volume and scope of B.T.C. research has increased as the modernisation programme has developed. Research work in less well-known fields has included such diverse studies as the flow of air through pipes, leading to improvements in vacuum brake design ; the stability of long-welded rails, with subsequent improvement in track standards ; behaviour of axle bearings, leading to smoother riding ; improvement of adhesion between steel wheel and rail ; new forms of insulation for 25kV a.c. electrification ; and automatic recording of freight wagon movements.

The studies under operational research have included the impact of wagons during shunting ; speedy transmission of information for traffic purposes ; and fluctuations in traffic flow and use of regular-interval services to make more intensive use of rolling stock. In chemicals, research has covered among other things studies of the effects of diesel engine exhausts ; analysis of oils to determine engine wear ; and the development of new paint finishes which are more durable and reduce repainting costs.

Three Technical Development Units established at Stooperdale works (near Darlington), at Derby, and at Leyton (London), have enabled new ideas to be worked out, tested and applied more quickly and widely than before. The Stooperdale unit deals with design of rolling stock, freight containers, heating and ventilating apparatus, and goods handling equipment. Development of automatic warning apparatus has been centred upon the Leyton installation, and the Derby unit is concerned with the performance and efficiency of diesel locomotives.

Many research studies have been completed, others continue, and some have been developed to the point where practical application is under trial. Some examples of the latter are :

(i) Wheel adhesion : new methods of distributing sand, and further examination of chemicals, notably silicates, to improve adhesion between wheel and rail.

(ii) Engine oil analysis : the amount of contaminants in the oil is measured by a spectrograph, and correlated with known data about the engine. The ultimate objective is to be able to forecast for those responsible for engine maintenance the state of a particular engine at any time without dismantling.

(iii) Signalling : transistor techniques have been applied to the control and indicating elements of electric signalling systems, and a number of installations are working. Study is now being directed to applying these techniques to other aspects such as signal interlocking and track circuits which are primarily responsible for safety. They must, however, first show they can surpass the record of reliability of existing track circuit relays which can operate for five years in a sealed box, and have a failure rate of only one in thousands of millions of operations.

(iv) Electrification equipment : resin-covered glass-fibre cables have been developed to support the live parts of the overhead electric wires used in railway electrification on the 25kV a.c. system. This may result in very substantial savings in the cost of insulation and fittings. Some of these cables are already in use and it is hoped to extend their application.

Among other developments which are under examination are the adaptation of electronic computers for the speedier compiling of timetables ; and the automatic identification and recording of freight wagon movements by electronic apparatus which can scan identification plates fixed to wagons as they pass by and convey the information electrically to any selected point. Investigation is also to be made into the characteristics of a pair of rails used as a waveguide.

Electrodes

A RANGE of welding rods and low amperage electrodes now being marketed by Stubs Welding, Ltd., Warrington, are available for welding cast iron, aluminium, bronze, brass, copper, stainless and alloy steels. The makers point out that the electrodes developed for welding cast iron can be used for cold welding, and they will facilitate the carrying out of welding repairs *in situ*. Welded cast iron test pieces prepared by the firm failed at the parent metal not at the welded joints in a series of tensile tests.

[Reply Card No. E8252]

The Radiochemical Centre, Amersham

THE RADIOCHEMICAL CENTRE at Amersham, Bucks, is an organisation which has been set up within the United Kingdom Atomic Energy Authority to produce and market radioisotopes throughout the world. This Centre draws upon and combines two sources of service to isotope users—Amersham and Harwell. At Amersham work on radioactive substances began in 1940, when a small industrial laboratory was established to refine radium and to make self-luminous paints for military use. Later this laboratory undertook, as a service for British hospitals, the manufacture of radium appliances and the supply of radon for clinical use. At Harwell, since 1949, the isotope division of the Atomic Energy Research Establishment has engaged in research into the uses and properties of radioisotopes and has organised their production in research reactors. There has been continued development of this side of the isotope division's work, with special emphasis on the production of radiocobalt, radiogold, radioiridium, and other isotopes that need no chemical processing.

Because of the growing demands for these products and the diversity of operations involved in producing and marketing them, the resources of the two services outlined above were amalgamated in 1959, when the Authority reconstituted the Radiochemical Centre. The centre is an establishment of the Research Group of the Authority. Technical and commercial policy is decided by the Isotope Production and Marketing Board under the chairmanship of a member of the Authority. On this board there is representation of other groups, particularly the production group, whose reactors make a major contribution to isotope production. As it is in close touch with Harwell, the Radiochemical Centre can make good use of the research reactors which still provide the basis for isotope production in Great Britain. There is also close liaison with the Isotope Research Division, which studies the fundamental properties and new uses of radioactive isotopes and includes a technological irradiation group which is developing the industrial use of large radiation sources.

By the nature of its work, the Radiochemical Centre at Amersham is a scientific establishment but it is organised on commercial lines. It has four production departments (organic, inorganic, isotope production and natural radioelements) and engineering, physics and analytical technical services. Financial control, production planning and marketing are the functions of the commercial department.

Production at Amersham is concentrated on the four main sources of radioisotopes: (1) and (2) by irradiation either in a nuclear reactor or in a cyclotron; (3) uranium fission products; and (4) the natural radioactive elements. Ninety-seven different isotopes are listed in the Radiochemical Centre's catalogue ("Radioactive Chemicals," published by the U.K. Atomic Energy Authority); of these isotopes seventy-one originate from reactor irradiation, four from cyclotron irradiation, sixteen from fission products, and six from natural sources.

In certain cases the radioactive product is made in a single routine operation by irradiating the appropriate inactive material such as cobalt, iridium or gold. For routine production of this kind the principal reactors at Harwell are equipped with handling mechanisms for loading and discharging small targets. For special irradiation under intense neutron bombardment in "Dido" and "Pluto" at Harwell, special rigs are required for cooling the target.

While the isotope production capacity of research reactors is limited, much larger capacities are expected to be available in the civil power station reactors that are now being built or planned. Accordingly, the Radiochemical Centre is collaborating with the Central Electricity Generating Board to exploit this potential capacity, which is expected to yield an annual output of (for example) millions of curies of cobalt-60 from the irradiation of more than 1 ton of inactive cobalt.

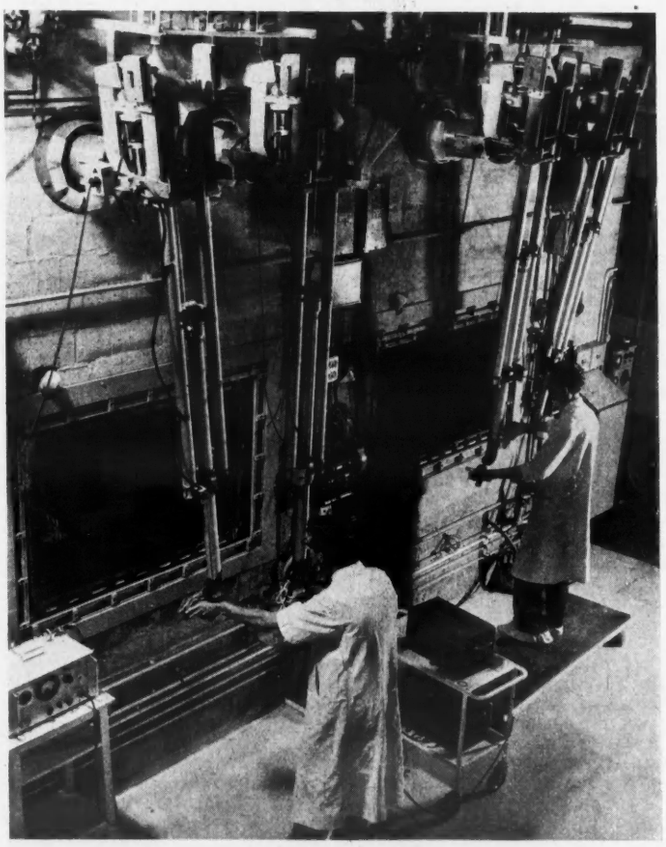
Whereas some isotopes can be used directly as discharged from the reactors, many must be chemically refined to separate them from unwanted materials. Refining of isotopes such as radioiodine, radiophosphorus, radiocarbon, radon and polonium are routine operations, but others require special chemical procedures in screened cells.

From all these operations nearly one hundred "primary" isotopes can be produced in simple chemical form; some of them can be used without further chemical processes but the majority must be converted into radiation sources or "labelled" compounds.

When the radioactive material is to be used as a radiation source its form must be such as to resist accidental dispersal. With penetrating gamma emitters this condition can be achieved by sealing the material in metal capsules or by containing it in special appliances such as platinum needles for radiotherapy. Beta emitters, however, present some difficulty, since the container must be mechanically robust without absorbing the radiation: such isotopes are usually fused into ceramics or embodied in silver foil by metallurgical processes.

The primary isotopes are also the basic materials for making "labelled" compounds—that is, organic or inorganic compounds which are "labelled" by the substitution of a radioactive isotope for one or more of the atoms in the original compound. The main difficulty in this class of isotopic chemistry is that carbon dioxide is the only usable source of radioactive carbon. Since ten successive stages of synthesis may be needed to make some of the compounds and since the carbon-14 involved in the processes is a valuable material, high efficiency must be maintained in each stage of synthesis. Usually chemical synthesis is used but sometimes biosynthesis is preferred.

Equipment for remote mechanical handling of radioactive materials during their processing is much in evidence at the Radiochemical Centre. A typical example can be seen in the accompanying illustration which shows about two-thirds of a suite of three hot caves for the remote handling of kilocurie quantities of mixed fission products. This particular suite was designed to handle up to a kilocurie of cæsium-137 or corresponding amounts of mixed fission products. It is used to isolate the more important fission product isotopes and produce cæsium-137 gamma-ray sources for industrial radiography and medical therapy units. Each cave consists of a large steel dry-box surrounded by 3ft thick concrete walls of density 148 lb per cubic foot. Operations are carried out inside the cave with Argonne model-8 manipulators and are viewed through a 3ft thick zinc bromide window which has a viewing area of 4ft by 2ft 6in. The window is bolted directly on to the cave dry-box and its inner surfaces consist of two sheets of 1in thick cerium stabilised glass. The three caves are interconnected and served by an electric railway which runs the length of the suite and into a dry-box built into the concrete wall of the end cave. This dry-box is designed for servicing equipment used in the caves and as a transfer area for items entering and leaving the suite.



Part of a suite of three "hot" caves for handling mixed fission products in quantities up to kilocuries

Some Industrial Uses of Radioactive Isotopes.—Radioactive isotopes are widely used in industry tracer investigations and for quality control of products. Uses of radiation on an increasing scale are envisaged in the manufacture or processing of materials. One of the more important industrial applications is the radiographic inspection of castings, forgings, stampings and welds: cobalt-60, iridium-192 and cæsium-137 are widely used for this sort of work. Applications in the non-destructive testing of materials include the measurement (and, if required, feedback control) of the thickness or density of sheet materials or coatings, using beta-gauges. There are many miscellaneous uses such as leak detection in process plants, studies of problems of mixing of materials and the measurement of heat.

As cobalt-60 is now available in quantities totalling millions of curies, radiation is now a practical means of processing materials or (for example) of sterilising packaged materials without heat and after the packages have been sealed. The first major applications are expected to be in the sterilisations of medical and pharmaceutical supplies. In Australia the system is in use for killing anthrax bacilli in bales of goats' hair used for carpet making. The preservation of foodstuffs by sterilisation, and the production of chemicals, are likely to provide further outlets for the development of large radioactive sources capable of providing several kilowatts of radiation energy. It is estimated that about 700 firms in Great Britain were using radioactive isotopes last year.

SHORTER REPORTS

Wakefield Memorial Lecture

On Tuesday last the Wakefield Memorial Scholarships for 1959–60 were presented to students of the College of Aeronautical and Automobile Engineering by Captain George Eyston, O.B.E., M.C., M.I.Mech.E., M.S.A.E., a director of C. C. Wakefield and Co., Ltd. The Wakefield Memorial Lecture, entitled "The Driving Need," was given by the Hon. Brian Rootes, and was devoted to the necessity of roads in an industrialised community. We reproduce parts of the lecture below.

In 1958, the Government initiated a four-year road programme. It pledged a spending of £280 million on building a modern motorway network throughout the country by 1962, and last year the then Minister of Transport announced that after 1961 the Government would spend £66,000,000 a year on major construction and road development.

This was better news, but my delight is tempered considerably by the news that Western Germany is now building autobahnen at the rate of 125 miles a year, and it looks very much as though the condition of our roads relative to the volume of traffic will be worse at the end of the Government's four-year plan in 1962 than it is to-day.

The plain fact is that Britain has spent less on road construction and maintenance in recent years, both per vehicle and as a share of the gross national product, than almost any other European country—and by the look of it, we will stay at the bottom of the league throughout the early 'sixties at least.

In 1959, road users in this country contributed £564 million in taxation. Only 15 per cent of this was spent on roads, and this represented a minute 0·66 per cent of our gross national product.

Compare these figures with the £3000 million spent by the U.S.A. on its roads in 1958 ! This represented 2·8 per cent of their gross national product and they, in fact, were so road-minded that they spent some £394 million more on their roads in that year than they took in taxation.

We also lag steadily behind the developed countries of Western Europe. Remember we spent on roads 15 per cent of road user taxes, yet Western Germany spent 97 per cent, Belgium spent 42 per cent, France spent 42 per cent, and even Italy spent 37 per cent.

Does it look in the future as though we will plough back the money we need into road building ? According to the British Road Federation it seems most unlikely. They estimate—basing their calculations on a recent statement of the Minister of Transport—that by 1965 our expenditure on roads would only have increased to £127 million, which is still well behind the figure which Western Germany spent as long ago as 1956. By the look of it, we have still not learned our lesson.

It is saddening to think that the majority of the £5,000,000 of capital equipment used to build the M.1 is now lying in dumps, and the expert 5000-man force assembled to do the work has been disbanded—all because no equal project was ready when the M.1 was completed.

Three years ago an Institution of Civil Engineers conference decided that we needed to spend a minimum of £3500 million on our roads to stay industrially and economically alive. It seems a lot of money, but measured against the railways' £1500 million investment programme it can be seen in better perspective—and railways are declining because they are proving to be a less economic form of transport in the modern world !

Perhaps the first and most outstanding impression that one receives of our present road programme is the surprising lack of urgency in its implementation. So often do we see road repairs brought to a halt at five o'clock in the afternoon and only resumed at eight a.m. the next day—despite the congested nature of the road under repair. The road problem is growing worse by the minute, and it is false economy not to have round-the-clock working at traffic bottlenecks. Can anyone doubt the need for a more urgent approach, when one considers that it took nearly as long to build our solitary flyover at Chiswick as it did the Brazilians to erect the heart of Brasilia, their new capital, high in the jungle !

There are many improvements which could be made to our present road programme and traffic regulations—improvements which, planned for now, could greatly ease the strain on road users. We should, for instance, further reduce the number of right turns which can be made off busy roads, for these are a constant source of accidents and traffic congestion. We must also, wherever we can, separate the various types of road users ; motorists, cyclists and pedestrians.

The age of the roundabout, too, is surely over. I class railway level crossings in the same outdated category as roundabouts.

Road accidents, of course, are of great public concern. We must certainly continue an active propaganda campaign for better driving, but there is only one real way of stopping accidents, and that is to improve roads. It is significant that the U.S.A., with its fine road system, has a lower road fatality ratio per 1,000,000 people and per 1,000,000 vehicles.

It is nonsense to say that we cannot spare land for new roads. At the moment, built-up areas comprise only a fraction of Britain's 56,000,000 acres, and our annual loss of agricultural land to urban development is running only at 0·1 per cent of this figure.

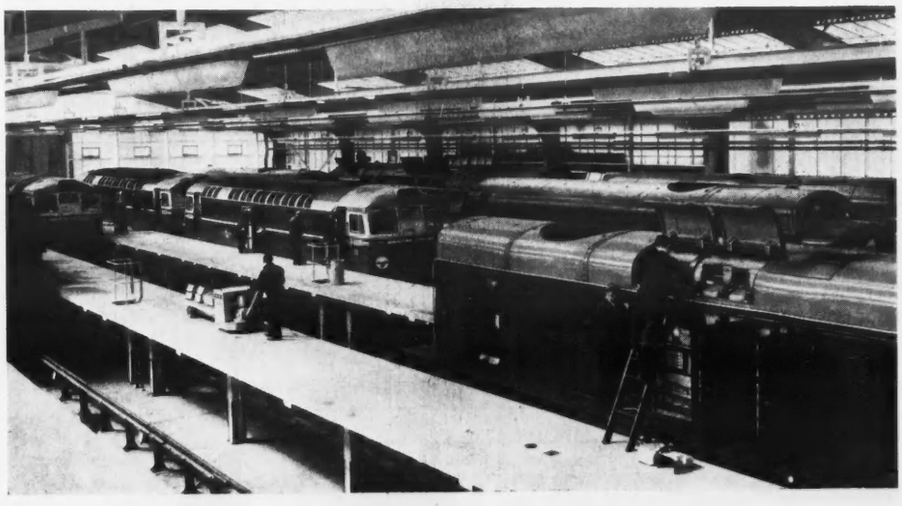
Diesel Locomotive Maintenance Depot

A new depot for the maintenance of diesel locomotives has been opened by the Eastern Region of British Railways at Finsbury Park, at the side of the Great Northern line some 2 miles from King's Cross. This depot is equipped and organised for the regular maintenance of nearly 200 locomotives, ranging from 350 h.p. shunters to the 3300 h.p. main-line "Deltics." At present, it is mainly concerned with the daily servicing of locomotives, but it is planned for the depot to deal eventually with periodical examinations and heavier repairs.

The main locomotive shed is a steel-framed single-span structure, across the 111ft 6in width of which there are six sets of tracks, each taking up to three locomotives. Its sides are fully glazed over dwarf brick walls, and this, combined with the continuous glazing of the roof, gives an exceptionally high level of natural lighting throughout the working areas. In order to give the best possible degree of accessibility to all parts of the locomotives, an interesting track arrangement has been adopted. The rail tracks are carried on tubular columns about 20in above the main floor level so that all the running gear is at a convenient working level from the side. Between the tracks and along their full length are shallow pits in which a man can stand to work on the underside of the locomotive. Central columns along the paths between the tracks carry concrete platforms at cab floor level from which the workshop staff can easily reach the uppermost parts of the engine. This "three-deck" arrangement can be seen in the photograph we reproduce. The pits, and both side working levels are provided with adequate electric lighting and low voltage plug-in boxes along the sides of the pits provide means for quickly introducing portable lamps at any required point.

The building is well heated, and large knife-jack folding doors can be closed in cold weather. All piped services—compressed air, water, oil, &c., are carried along the underside of the platforms and coupling points provided on the main columns. Adjoining the building is a boiler-house providing hot water for heating purposes, and the boiler is fired by the dirty oil drained from engine crankcases, which is pumped into large storage tanks.

Ancillary shops at one end of the main shed are equipped with light machine tools and benches for minor repair work, oil filter cleaning plant, battery charging, and engine injector testing. Fuelling and sanding stations are provided on the lines leading out of the north end shed, and a separate two-storey building at the south end provides accommodation for offices, stores, and staff amenities.



Interior of main shed of diesel locomotive depot

Proprietary Disc Brakes

It has been announced by Ferodo, Ltd., that the development of a range of disc brakes of various sizes designed to use "DS5" friction material has now been completed ; these brakes are distinctive in being rated in terms of their heat dissipating capacity, ¾ h.p. to 65 h.p. The brakes, of spot-type single-disc fixed-caliper construction, are spring-applied, solenoid-released. They will be available from De Bergue Machine Tools, Ltd., towards the end of 1960.

[Reply Card No. E8273]

SHORTER REPORTS *(Continued)*

New London Computer Centres

Two establishments in London for computer services were inaugurated simultaneously on April 28, when Lord Mills, the Paymaster General, performed an opening ceremony over closed-circuit television from Hamilton House, 138, Piccadilly, W.1, where International Computers and Tabulators, Ltd., has a new demonstration centre. The other establishment opened at this double ceremony was the I.C.T. computer centre at Putney Bridge House, London, S.W.6. Hamilton House enables the company, for the first time, to display under one roof its full range of punched-card equipment. Putney Bridge House now accommodates the I.C.T. Computer Group, which is being expanded to comprise over 200 specialists and supporting staff. The two main sections of this group are the applications department and the central programming service. Personnel of the applications department are systems analysts with experience of office and factory mechanisation, whose function is to give practical help to prospective users, actual users and I.C.T. staff. The central programming service will include among its activities the compiling and maintenance of a library of programmes and sub-routines, and research into programming techniques and methods. It will advise customers on the writing of programmes and, if necessary, write programmes on a fee-paying basis.

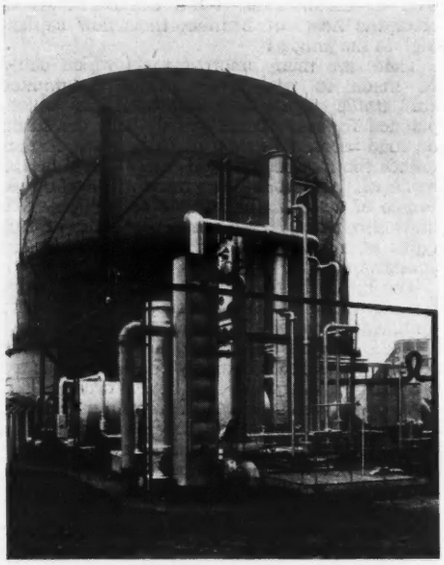
The computers installed at Putney Bridge House will be used for testing customers' programmes, service work, demonstrations and to provide facilities for the computer group to test the results of its own research. One-day and four-day appreciation courses for management will be held at these premises to give a comprehensive introduction to the electronic computer in business and industry. A new magnetic tape data processing system is to be added shortly to the installations at Putney Bridge House.

[Reply Card No. E8281]

Drying Town Gas by Refrigeration

A NUMBER of gas dehydration plants using calcium chloride as the drying agent has been built by W. C. Holmes and Co., Ltd., of Huddersfield, and now the first plant for drying town gas by refrigeration has been installed by the firm at the Lostock Hall gas works, Preston. This plant, the first of its kind in the United Kingdom, was primarily installed to dry the high-pressure gas supply boosted to Blackpool, but as it was not anticipated that boosting would be a continuous operation the plant was also designed to dry local low-pressure supplies as a secondary process. When high-pressure gas boosting is in operation, refrigerated brine is used for cooling the high-pressure stream. Surplus chilled brine not required for the high-pressure stream, is used to cool the local town gas supply. In this way, maximum use is made of the refrigerating plant capacity, and a useful degree of gas dehydration is maintained on local low-pressure supplies.

The plant, to be seen in our illustration, is



Gas dehydration plant at the Lostock Hall works of the North Western Gas Board

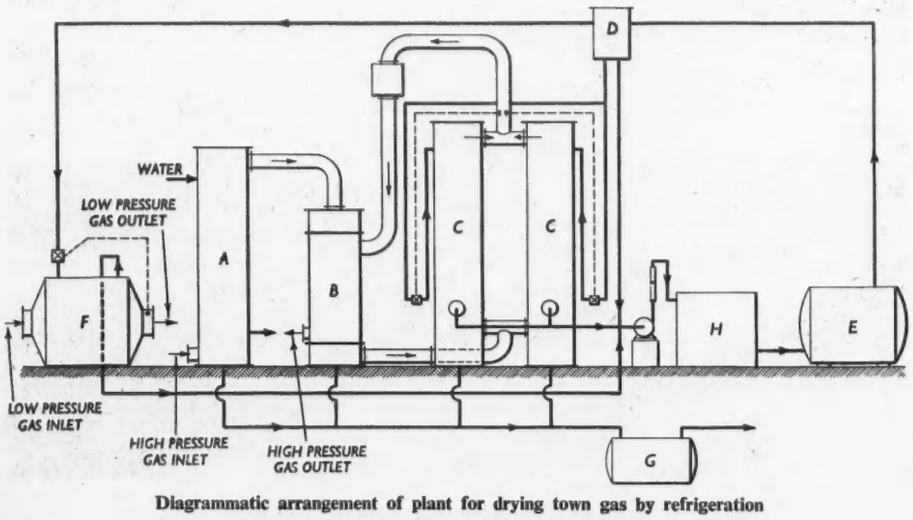
designed to handle 5,000,000 cubic feet of gas per day at pressures of 10–16 lb per square inch gauge, and to chill the boosted gas to a dew point of 37 deg. Fah. at all times of the year. Dependent on the load and ambient temperatures, it can also produce an average reduction in dew point of approximately 6 deg. Fah. in the local low-pressure gas stream.

Referring to the diagram we reproduce, when the plant is in operation the high-pressure gas, at approximately 8-10 lb per square inch gauge, passes through the after-cooler *A* where the heat of compression is removed. The gas is then cooled in a heat exchanger *B* with the final chilled gas before passing to the main cooler *C*. The main cooler, which is of cross-tube design, is fed with chilled brine by way of a constant head pot *D* from a 6000-gallon chilled brine storage tank *E*. The chilled gas passes through a mist catcher and finally cools the incoming gas.

Any surplus brine pumped up to the constant head pot and not required for high-pressure gas cooling, is diverted to the low-pressure cross-tube design gas cooler *F*. Both coolers are fitted with condensate drains, and the condensates from them and the heat exchanger are collected in a condensate tank *G*, utilising the gas pressure to discharge the liquid. The circulating brine is cooled in a standard compressed ammonia refrigerating plant *H*, which—together with the high-pressure coolers, brine circulating pumps and instrument air compressors—is supplied in duplicate to avoid any interruption to the process should mechanical troubles develop or when the plant is being serviced.

Dew points of the cooled gases are controlled by air-operated brine control valves, working in conjunction with cool gas temperature recorders and controllers. Cooling of the circulating brine is controlled by a thermostat in the 6000-gallon brine storage tank. This tank, which is kept full, provides at least two hours' reserve of chilled brine when the refrigeration plant cuts out, thereby avoiding rapid on/off cycles. Cooled brine temperatures are generally between 30–35 deg. Fah., and at these temperatures there is no tendency for ice to form in the gas coolers. It is stated that in practice the plant has operated for several hours with the brine at 25 deg. Fah. without any increase in cooler back pressure which would suggest that no ice is formed at this temperature.

[Reply Card No. E8282]



Diagrammatic arrangement of plant for drying town gas by refrigeration

Commonwealth Telecommunications Board

THE third technical and traffic meeting of the Commonwealth Telecommunications Board is being held in London. These periodical meetings, held previously in 1950 and 1955, bring together telecommunications experts from many parts of the Commonwealth and enable them to exchange experiences, examine new developments in the science and technology of telecommunications, and consider the practical application of new techniques in radio and cables to the Commonwealth telecommunications system. At the present meeting problems of mechanisation in the international telegraph services is a main feature. The chairman is Sir Ben L. Barnett, who is also chairman of the Commonwealth Telecommunications Board. It is expected that the meeting, which was opened on May 3, will last some three weeks, and at its conclusion a report will be made to the Governments.

In opening the London meeting, the Postmaster-General, The Rt. Hon. Reginald Bevins, said the outstanding achievement since the last meeting had been the laying of the first trans-atlantic telephone cable, a joint enterprise of the United States, Canada and the United Kingdom. The cable was also an important component of the Commonwealth Telegraph Service, and its success was leading quickly to the second—"Cantat"—in the Commonwealth as well as others outside. Plans were now well in hand for the construction of the second major link in the Commonwealth telephone cable network linking Canada, Australia and New Zealand. The challenge of high-speed, large capacity cable systems had been matched in radio by a development that would ensure a long continuing use of radio for telegraph communication, namely, systems which automatically corrected the errors that inevitably arose when atmospheric conditions caused signals to be mutilated. This development had greatly improved the reliability of radio telegraph communication and allowed radio to be used for services such as international Telex on a far wider scale than had been thought possible.

Exhibition of Storage Equipment

FROM Monday, May 2, to Friday, May 6, an exhibition of its products was held by James H. Randall and Son, Ltd., at the new factory buildings forming part of its Paddington Green works, London, W.2. This company, which was founded over a century ago when Robert Randall opened a small tinsmith shop in Bird Street, Marylebone, now manufactures a wide variety of products, including dairy and ice-cream equipment, transport containers, and storage systems for the factory and the office. The works are well-equipped to carry out press work, light assembly work, welding by various systems, while the Randall 1851 organisation has capacity for the forming, moulding and fabrication of plastic sheeting and for precision engineering to the trade.

In the new section of the works, which has been built to conform with local redevelopment of the area, the division of the office area will be by partitioning of the company's own design and manufacture. A length of partitioning fabricated from press-formed panels and frame members, strengthened and linked by " U " shaped uprights, was already in position. An example of " Randalrak " storage was on view and a short film was shown which illustrated the saving of space effected by designed-for-purpose storage and its flexibility, together with the advantages of employing " Randalrak " trolleys in association with the stores system. For office purposes the exhibition included examples of drawings storage, a multi-cell plastic draw unit, and of both " Referendus " and " Readyrecord " filing furniture, together with a range of multi-cell plastic trays.

Another storage system on view was the " Microstore," which consists of a four-pillared free-standing structure carrying a pair of Coburn tracks fitted with roller suspended frames. These can be closed up and locked to produce self-contained dust and pilfer-proof storage. The frames can be fitted with trays and bins as required to provide a variety of shaped subdivisions to suit the storage required. Also in the exhibition were examples of equipment manufactured by the company for the dairy trade, including mechanical freezing cabinets, ice-cream storage and transport containers and vendors, together with portable insulated hot water tanks for use in service vans.

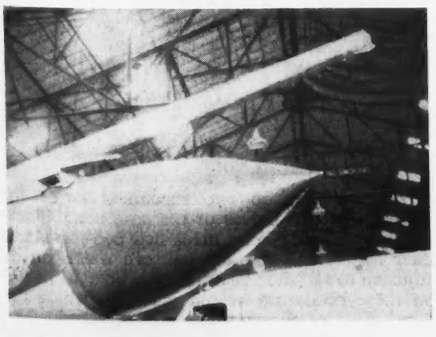
[Reply Card No. E8291]

Interceptor Upgraded

WE recently visited the aerodrome at Moreton Valence of Gloster Aircraft Company, Ltd., where the works is largely occupied with the inspection, repair and extensive modification of " Javelin " all-weather fighters. It will be recalled that the later marks of this aircraft are armed primarily with the D.H. " Firestreak," the infra-red guidance of which imposes upon the defence a pursuit course interception regardless of the capability of the A.I. radar. To render this restriction less prejudicial, the Mk. VII aircraft with Armstrong-Siddeley " Sapphire " 7 engines are being provided with reheat in order that less speed is lost in the final turn and that speed is more rapidly regained during lock-on ; this modification brings a Mk. VII up to the standard of a Mk. VIII, and the modified machine is designated a Mk. IX. Aircraft with afterburning are recognisable, not only by the variable nozzles (see page 402, September 12, 1958) but also by two scoops above the fuselage inducing cooling air for the tail-pipe shrouds. Since reheat is intended solely to allow the aircraft to be flown further from the stall margin at high altitudes, it has been developed to demonstrate reliable ignition in the altitude range 20,000ft to 45,000ft. The (small) increase in thrust available with afterburning increases the altitude at which operation is possible, and so the leading edge is " drooped " to delay the stall. The " droop " on the " Javelin " is not the sharp local distortion of the section seen on some swept-wing aircraft, but rather a gentle increase of camber towards the tip, and, in fact, the appearance is rather that of wash-out. This modification causes the stall, instead of starting at the tip and spreading inboard, to commence at the trailing edge and move forward. It should perhaps be mentioned that the spinning characteristics of the " Javelin " are such that pilots are instructed not to stall the machine, and, in fact, the later marks have not been stalled even experimentally ; even without a stall warning device, ample warning of nearing the stall is offered by buffeting. The minimum speed used in the approach, it may be observed, is dictated, not by the minimum power speed or loss of visibility with increasing incidence, but by decrease of lateral controllability. The modified aircraft have auto-stabilisation about yaw and pitch axes, the latter effected through the ailerons, but unlike the Mk. VIII do not have auto-pilots.

In order to increase the range of the aircraft when ferrying from one base to another, a flight refuelling system that can be fitted by first-line personnel has been developed. This includes a very large and conspicuous probe faired into the nose high up on the starboard side, connected by piping running above the upper surface of the wing back to the main fuel tanks behind the cockpits.

[Reply Card No. E8292]



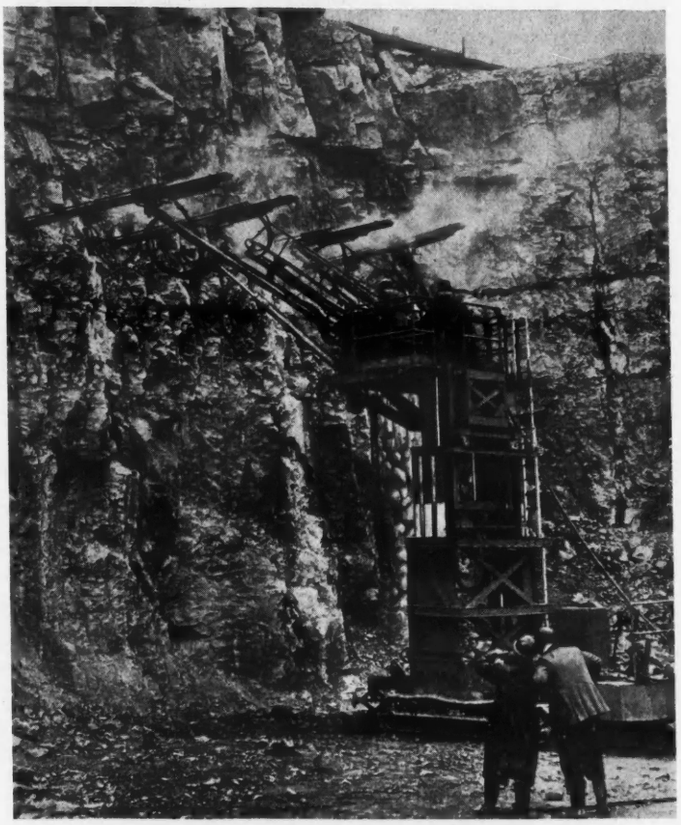
" Javelin " flight refuelling probe: the actual nozzle is not in place

Mobile Rock Drilling Rigs

TRIALS were recently carried out in a Derbyshire quarry of the first of fifteen mobile tracked tower drill rigs being built for Russia by the Climax Rock Drill and Engineering Company, Ltd., in conjunction with F. Taylor and Sons (Manchester), Ltd. These machines, as can be seen from our illustration, consist of a tracked chassis on which there is mounted a telescopic tower with a drilling platform carrying four hydraulic boom-mounted drifters which can be operated by two men.

The tracks of the machine are driven by 40 h.p. electric motors and enable the machine to negotiate rough uneven ground on gradients up to 1 in 7. Hydraulically-operated crowding rams fitted on the machine have a stroke of 30in, and enable the feed cradle to be pushed up to the rock face. The telescopic tower has five nesting sections which are extended by hydraulic rams through a system of wire ropes and pulleys. When collapsed the tower has a height of 11ft, and when extended it enables holes to be drilled 32ft above ground level.

The four hydraulic booms on the drill platform each carry a Holman medium weight drill on a power feed cradle giving a feed length of 13ft, and these booms can be adjusted to cover a horizontal span of 24ft. Holes can be drilled at all angles from slightly dipping below horizontal to up to 30 deg. over the horizontal. All movements of the machine are controlled from panels on the drill platform and hydraulic power is supplied by a 7½ h.p. motor-driven pumping set on the main chassis.



Telescopic tower mobile rock drilling rig with four boom-mounted drifters. Holes can be drilled with this machine from ground level up to a height of 32ft and over a width of 24ft

[Reply Card No. E8293]

Metallic Valve Seals

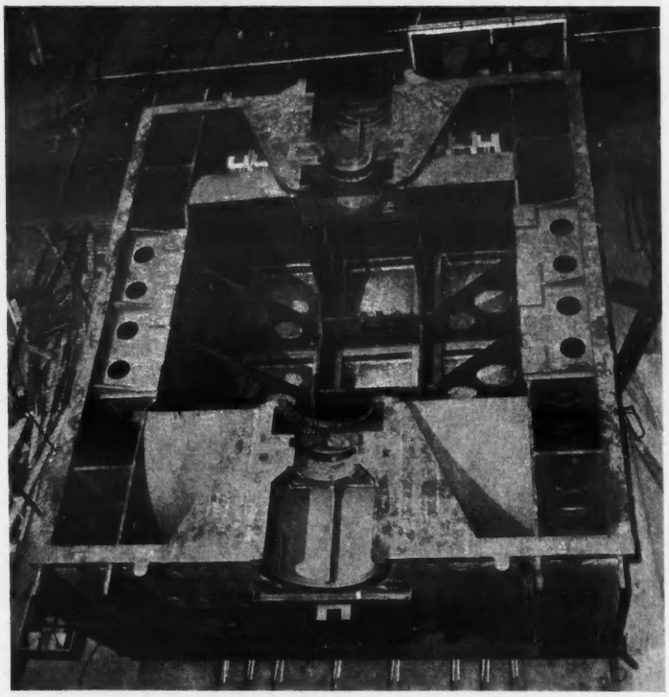
CONSIDERABLE numbers of vacuum valves using expendable metal or non-metallic seals are used in the laboratories of the United Kingdom Atomic Energy Authority, and difficulties have been experienced because existing types of metal seals have a very short operational life involving a lot of maintenance, while non-metallic seals cannot be used at high temperatures. To overcome this problem Harwell engineers and metallurgists have developed a sealing system which provides a new metal seal at each closure to give an efficient vacuum over a much longer life.

In this system there is used a deformable metal valve seat washer which, by plastic flow, forms a seal through pressure from a flange on the nose portion of the valve. When the nose portion is withdrawn, its flange forces the washer to a position similar to its original position in the valve seat. Work-hardening of the seal may occur after repeated use, but this can be relieved simply by baking the entire valve to anneal the washer.

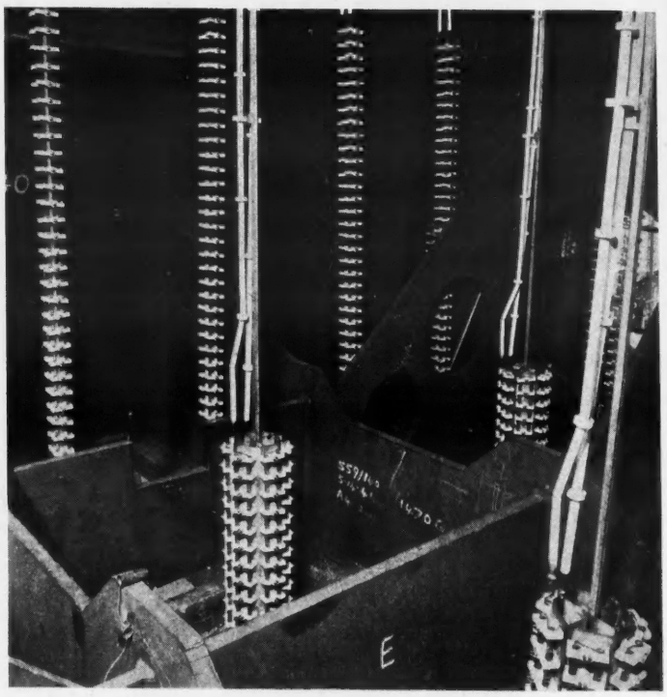
Materials from which these deformable washers can be made include gold, platinum, palladium, copper, aluminium, lead or alloys of these metals having suitable ductility.

[Reply Card No. E8294]

SHORTER REPORTS *(Continued)*



Bottom-half turbine exhaust casing of the G.E.C. 200MW set for Kincardine generating station. This fabricated structure was stress-relieved electrically, at the maker's Erith engineering works



Some of the sixty-eight, 7½kW radiant electric elements mounted for stress-relieving the bottom-half turbine exhaust casing of the 200MW set for Kincardine generating station

Radiant Electric Heating for Stress-Relieving a Welded Turbine Exhaust Casing

RADIANT electric heating for stress-relieving has been successfully applied at the Erith engineering works of The General Electric Company, Ltd., to a welded-steel bottom-half turbine exhaust casing of a 200MW turbo-generator. Two of these G.E.C. 200MW machines are being manufactured for extensions to the Kincardine Generating Station of the South of Scotland Electricity Board.

It was decided to fabricate the two bottom-half turbine exhaust casings for each of these machines as complete units and carry out the stress-relieving by electric heating. This was a departure from the company's normal practice on large reheat turbo-generators : the exhaust casings have previously been made in sections which were stress-relieved in conventional furnaces before being bolted together to form a complete component. Each of the Kincardine casings weighs 47 tons, the overall dimensions being 21ft 3in by 17ft by 8ft 3in high.

Because of the amount of metal and the complicated nature of the structure, calculations showed that it was necessary to use sixty-eight single-phase radiant heating elements each of 7½kW rating. The positions of the heaters within the casing were arranged to ensure even heating throughout the structure, and each heater could be individually controlled.

Two views of the installation are reproduced above : one shows the bottom-half casing and the other shows some of the heating elements. The casing was placed on a firebrick base and most of the heating elements were suspended vertically inside although a number were floor-mounted at predetermined points. After covering the open top with a ½in steel plate, the whole structure was encased in thermal insulation to a depth of 6in. Forty-two thermocouples disposed about the casing were connected to seven six-point graphic recorders for temperature measurements. It was thus possible to record average conditions in the whole casing during the heating operation and individual heaters were switched to maintain uniform heating.

When the temperature reached 650 deg. Cent. the power input was reduced to keep the temperature constant while the casing "soaked" for three hours, and then the heaters were switched off to allow the casing to cool to ambient temperature.

The power supply for the process, totalling 510kW, was taken from a 750kVA transformer feeding a busbar system at 400V through a 1000A switch-fuse. Although in this instance the heaters were controlled manually, the system is well suited for automatic control.

For manufacturers dealing with large welded-steel structures which need stress-relieving, the radiant electric method is attractive in that the operation can be carried out, closely controlled, in the manufacturer's works or elsewhere (if a power supply is available) without any limitations imposed by the size of the work or the availability of a furnace installation.

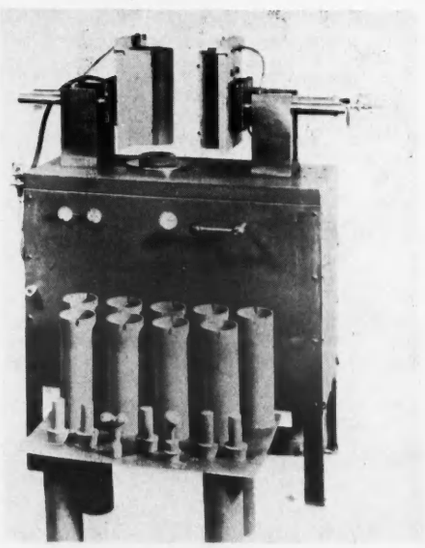
We learn that the G.E.C. is now able to offer advice and to supply the necessary electric equipment to manufacturers wishing to carry out similar large-scale stress-relieving processes.

[Reply Card No. E8301]

Shell Core Blower

A MACHINE for producing shell cores from pre-coated resin sands introduced by the Foundry and Metallurgical Equipment Company, Ltd., of Weybridge, Surrey, is designed to give up to 180 blows an hour, depending upon the type of core and the number of cores per box. Operation of the machine is by a six-position control lever. In the sequence of operation after closing of the core box and raising the sand chamber to seal the core box entry, the cores are blown. The air is then exhausted from the sand chamber, the chamber lowered and the core box opened for removal of the cores. A pneumatic vibrator, operated by a push button, empties sand from the cured shells and reduces wastage. An automatic air nozzle and hose is fitted for clearing residual sand from working surfaces.

The machine is illustrated below; its blower is enclosed in a floor standing cabinet which



Shell core blowing machine for resin sands

carries on the top two machined heads for holding the two halves of the core box. These heads are aligned on a machined bed-plate, and their height and the gap between them can be adjusted to suit the size of the core box. Mounted on these heads are heated plates to which the two halves of the core box are attached. The left-hand plate is fixed and the other is moved by a heavy-duty pneumatic cylinder to open and close the core box. The sand chamber under the bed-plate consists of a solid drawn steel

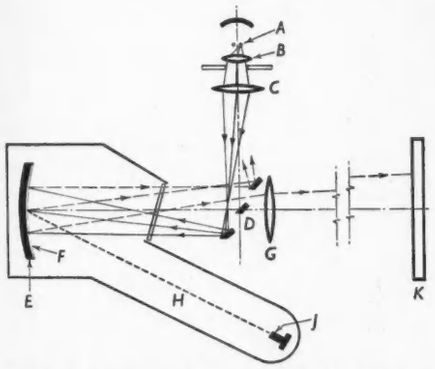
cylinder which is raised and lowered through an articulated linkage system operated by an air cylinder. The height of the sand chamber in respect to the core box is adjusted manually and a pneumatic cylinder closes the gap prior to blowing. The standard sand chamber has a capacity of 35 lb, but larger chambers are available. The heated plates of aluminium alloy have cast-in heavy-duty electric elements and each plate is controlled by an energy regulator enabling the heat input to be set according to the size of the core box.

[Reply Card No. E8302]

Large Screen Colour Television

SINCE 1951 the Swiss chemical combine, C.I.B.A., has supported development of the "Eidophor" television projection system based on the invention of Dr. Fritz Fischer, of the Swiss Federal Institute of Technology, and manufactured by Gretag A.G., of Zurich. Last week a demonstration of the system was given in Manchester by C.I.B.A. Clayton, Ltd., sole concessionnaire in the United Kingdom for C.I.B.A., who arranged a broadcast in colour from its technical service laboratories of a programme on dyeing processes. The items were seen by a large audience at Belle Vue, Manchester, on a screen of approximately normal cinema dimensions, after transmission by a microwave link over the 1½ miles from the laboratories.

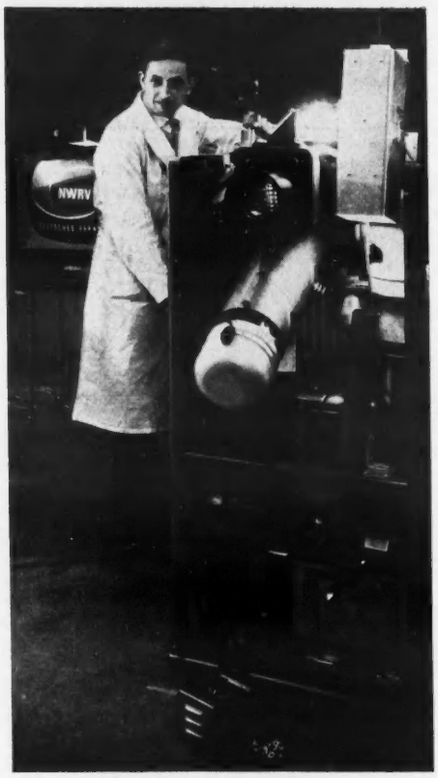
The principles of the "Eidophor" system are seen in the accompanying diagram, which shows



Principle of "Eidophor" system, showing paths of light between projector lamp *A* and screen *K* via mirror *E* and mirror bar system *D*

it in its basic form as a black-and-white projection system. Light from the projector source *A* is directed through condenser *B* and lens *C* on to the mirror bar system *D*. This may be compared to the slats of a venetian blind. The mirror bars are set so that light is reflected on to the spherical concave mirror *E*, the surface of which is covered by a fine and continuously renewed film of oil *F*. If the oil film is undisturbed, light is reflected back to the source and none reaches the screen through the gaps in the mirror bar system. Deformation of the oil film, on the other hand, changes the angle of reflection and allows a variable amount of light to reach the screen *K* via the projector lens *G*.

The beam *H* from electron gun *J* is modulated by the received television signals and scans the surface of the spherical mirror. The oil film has a positive charge, and the effect of scanning by the negative electrons is to set up electrostatic strains which deform the surface in the manner necessary to reflect a greater or less quantity of light through the mirror bar system, so that the black-and-white tonal values of the picture being transmitted are reproduced on the screen. The electron gun and spherical mirror are enclosed in a vacuum chamber, which is evacuated continuously by a pump. One of the accompanying illustrations shows this assembly as installed in a projector. The spherical mirror revolves slowly, mainly in order that the oil surface can be continually renewed and smoothed. Oil is forced by a pump through a filter into a spreader which takes the form of a slotted bar delivering a fine spray of oil on to the rotating mirror. A smoothing bar located close to the face of the



Television projectors in course of assembly, showing the cathode-ray tube which scans the oil film mirror behind the projection lens

mirror smooths the oil layer to an exact thickness of 0·1mm. After the oil has been smoothed and the oil layer has served its purpose, the rotation of the mirror allows it to flow away from the surface into an oil reservoir, and so back to the pump.

The electron gun operates with an accelerating voltage of 15kV and its cathode is heated to about 2500 deg. Cent. Cathode life at present is only about 100 hours and the tube assembly therefore provides three cathodes which can be interchanged under vacuum.

In the Manchester demonstration the projection light source was a 1·8kW Xenon arc lamp. Colour was produced by sequential scanning with red, blue and green filters at the camera, rotating in synchronism with similar filters at the projector. Synchronising pulses for this purpose were contained in the microwave television signal. Operating at seventy-five pictures a second, the system provided attractive colour-rendering without colour fringes except on rapidly moving objects. The rendering is strongly affected by the colour temperature of the studio lighting, and its sensitivity in this respect was demonstrated. Standard cameras were used, with image orthicon tubes, and transmitted a 525-line picture.

[Reply Card No. E8311]

Aircraft Tactical Radar

IT has been announced that Ferranti, Ltd., Hollinwood, Lancs, is actively engaged in the development of a Mark II version of the "Airpass" radar fire control system. It is intended to meet the requirements of various foreign governments for a fire control system for use against surface targets as well as aircraft. It uses the same pilot's attack sight as the original system, but is suitable also for two-seat aircraft.

As a fire control system it provides the following facilities :

(1) Air-to-air radar search and automatic target tracking.

(2) Computer controlled approach for blind or visual attacks with a variety of air-to-air weapons. ("Airpass" will handle collision course weapons as well as, of course, "Firestreak.")

(3) Radar-assisted attacks against surface targets with a variety of weapons.

In addition, because the approach to surface targets must often be made at very low level, the radar can be used as a navigational and low-flying aid, with the following modes of operation :

(1) Ground mapping.

(2) Contour mapping with warning of obstacles ahead and indication of the best way around them.

(3) Terrain clearance with steering signals provided to the pilot in his attack sight, enabling him to follow a chosen course in bearing and clear any hills along this course in the optimum manner.

All of these facilities are provided in "Airpass II" without appreciably increasing its size or weight over "Airpass," and at the same time maintaining its simplicity of operation and ease of servicing.

"Airpass II" has been specified for the export versions of the English Electric "Lightning" (yet to be sold), the Dassault "Mirage" III, and S.A.A.B. "Draken." In the "Lightning" the configuration of the radome is prescribed by its being the centre-body of the air intake, but the other aircraft allow unrestricted scanning angles.

[Reply Card No. E8312]

Stevenage By-Pass Motorway

WORK is to start this month on a 7½-mile motorway by-passing Stevenage and Hertfordshire villages on the Great North Road, A.1. The tender of Martin Cowley, Ltd., amounting to £1,787,803, has been accepted for the construction of the motorway.

At its southern end the motorway will leave a point on the Welwyn By-pass near the "Clock" junction, where a roundabout will be constructed. The road will sweep northward to the west of Woolmer Green, Knebworth, Broadwater and Stevenage, to a point near Graveley, where there will be connections with both A.1 and A.602, the Hitchin Road. At the latter point there will be a roundabout designed so that it can be converted into a two-level junction when the motorway is extended northward for 4½ miles to a point on the A.1 north of Baldock.

There will be one intermediate junction on the new road—a flyover in conjunction with a roundabout to connect with Stevenage New Town. Thirteen bridges and five subways will be constructed to cross over or under the motorway, which will have two 24ft wide carriageways and hard shoulders. Generally the space between the carriageways will be 13ft wide but, between Knebworth Park and Fishers Green, it will widen to 28ft to retain trees and plant new ones. The scheme has been designed for the Ministry of Transport by the county surveyor of Hertfordshire County Council, Lieut.-Colonel C. H. ffolliott, B.A., M.I.C.E.

Launches and Trial Trips

LONGWY, ore carrier ; built by the Ateliers et Chantiers de la Seine Maritime for the Compagnie Generale d'Armement Maritime ; length between perpendiculars 584ft, breadth moulded 76ft 9in, depth 45ft 11in, draught 29ft 10in, displacement 30,690 tons, deadweight 21,250 tons, speed 14·4 knots, six main holds, three 250kW diesel-driven generators and one 250 shaft-driven generator ; supercharged, single-acting, two-stroke, Mark 8 R.A.S.D. 76FCM/Sulzer diesel engine, 10,760 h.p. at 119 r.p.m. Trial, January 19.

MARON, cargo liner ; built by The Caledon Shipbuilding and Engineering Company, Ltd., for Alfred Holt and Co.; length overall 495ft, breadth moulded 65ft, depth moulded to upper deck 36ft, deadweight 9800 tons, sea speed 15 knots ; six holds, one 35-ton, two 15-ton, six 10-ton, and eighteen 5-ton derricks, electric winches ; three 330kW diesel-driven generators, turbo-charged oil engine, 8500 b.h.p. at 115 r.p.m. Launch, February 26.

TRESFONN, bulk carrier ; built at Belfast by Harland and Wolff, Ltd., for Skibsaktieselskapet Dalfonn, Stavanger ; length between perpendiculars 520ft, breadth moulded 70ft, depth moulded 42ft 9in, deadweight 8000 tons ; seven holds, three 200kW diesel-driven generators ; Harland and Wolff single-acting, two-stroke, opposed piston oil engine, 750mm bore by 2000mm combined stroke. Launch, March 1.

INDUSTRIAL NEWS

Engineering Statistics

The statistics which are collected regularly by the Board of Trade show that, in the month of February, the volume of production in the engineering and electrical goods industries was 13 per cent higher than a year earlier. Provisional estimates for March suggest that after allowing for the Easter holiday (which fell in March, 1959), production in the first quarter of this year was about 13 per cent more than a year earlier. The main point made by the Board of Trade is that, by contrast with early 1959, when expanding production in the engineering and electrical goods industries was mainly in the sectors producing consumer goods, growth in recent months has been in the capital goods industries. The flow of net new orders, the Board of Trade says, "expanded vigorously" in January and February and, despite increased production, orders on hand increased sharply. Since the end of last October, when order books began to grow, orders on hand have increased 10 per cent. The production index (1954 =100), at the end of February, for mechanical and electrical engineering was 129.

Employment

During March, the Ministry of Labour says, the number of people in civil employment in Great Britain is estimated to have increased by 5000 to a total of 23,343,000. Of that total, 8,754,000 were employed in the manufacturing industries, indicating a net increase in those industries during the month of 10,000. Among the more significant increases were the engineering and electrical goods group, in which the number of people employed rose by 5000 to 2,032,000, compared with 2,019,000 at the end of January, and vehicle building, in which there was an increase of 4000 during March, bringing the total employed to 911,000. On the other hand, in shipbuilding and marine engineering, the labour force declined by 2000 during March, the number employed being 261,000. Outside the manufacturing industries, the biggest increase in employment during March was in building and construction, where the labour force rose by 15,000 to a total of 1,509,000.

In the week ended March 26, the number of operatives working short time was 35,700. That was 700 fewer than a month earlier and 80,000 fewer than at the end of March, 1959.

Spare Capacity in Civil Engineering

In the annual report of the Federation of Civil Engineering Contractors, which has just been published, Mr. J. Maurice Laing, the chairman, draws attention to the surplus of managerial and plant capacity in the civil engineering industry. He says the time must come when the emphasis on the construction programme will change and that the civil engineering industry, which is concerned with heavy capital engineering projects, must become more occupied. Until that time, individual companies must remain as strong as possible and this will not be achieved, he believes, if contractors continue to take on unremunerative work. It is surely better, the report says, for contractors to do less work and avoid losses rather than weaken themselves by accepting contracts at less than cost.

The report, which contains a detailed analysis of the causes of shortage of small civil engineering contracts, reveals that a major factor is the high interest rate imposed on borrowing by local authorities which are large "buyers" of civil engineering works. Attention is drawn to the fact that in 1952 local authorities borrowed 85 per cent of their requirement at interest rates of between 3 per cent and 4¼ per cent from the Public Works Loans Board. In 1959 they were only able to borrow 8 per cent of their requirements from this source at rates varying between 5¾ per cent and 6¼ per cent. Local Authorities have to compete in the normal money markets at rates of interest that sometimes necessitate them postponing or even scrapping schemes. The report points out also that when Local Authority work has become short, many of these bodies which have direct labour organisations have, without competition, been able to maintain the turnover of these organisations, causing all reductions in volume of work to be borne by contractors.

It is added that an increase in the road programme could solve many of the civil engineering industry's problems. A recent survey shows that the industry has ample capacity, from its existing resources, more than to double the present programme. It is also pointed out that the United Kingdom, one of the most highly industrialised countries in the world, which is now going to face increasing competition from the European Common Market, devotes to new roads only half the percentage of the gross national product spent by any of the "Six," and only 21 per cent of that of Western Germany in particular.

Smoke and Dust Control

The Minister of Housing and Local Government has made orders transferring to the local authorities concerned the control of smoke, grit and dust from certain industrial processes in Liverpool, Manchester and the Sheffield area. Control hitherto exercised by the Minister's Alkali Inspectors in respect of these particular processes will in future rest with the City Councils of Liverpool and Manchester and with the Sheffield and District Clean Air Committee. These orders come into effect on May 23. They transfer control over smoke, grit and dust from Clarence Dock and Lister Drive power stations to the Liverpool City Council, and from Stuart Street power station and the producer gas plant at the Openshaw works to the Manchester City Council. A further order transfers to the Sheffield and District Clean Air Committee control over smoke, grit and dust from air and rotary furnaces for iron and steel, electricity works, producer gas works, certain ceramic works and (in view of the constituent local authorities' long and close association with the steel industry) electric arc furnaces up to 30 tons' capacity and tropenas. Among the processes the Minister has decided to exclude from the orders are gas and coke works, blast furnaces and open hearth furnaces. The Minister has decided to refuse applications made by six other local authorities (Reading and West Bromwich County Borough Councils and Jarrow, Luton, Redcar and Stalybridge Borough Councils) for transfer in respect of certain processes. No other applications have been made.

Under the Alkali, &c., Works Regulation Act, 1906, air pollution from a variety of industrial processes is controlled by the Minister's Alkali Inspectors. The processes registered for this purpose are in the main those giving rise to pollution problems which are unusually serious, or the prevention of which is technically difficult. The Clean Air Act, 1956, which among other things gave local authorities powers to deal with industrial smoke, grit and dust generally, placed on the Alkali Inspectorate the responsibility for dealing with smoke, grit and dust from processes registered under the Alkali Act. But it gave the Minister power to make orders which have the effect of transferring this responsibility to local authorities (or, as in the case of the Sheffield and District Clean Air Committee, to a joint committee of local authorities to which powers have been delegated by the constituent authorities).

The Minister takes the view that the transfer of control should at present be limited to the largest local authorities, employing experienced staff with the appropriate qualifications. Where control is transferred, he thinks that it should usually be limited to smoke, grit and dust from processes involving fuel combustion, and should only exceptionally include processes involving problems of chemical engineering. It is stated that the Alkali Inspectorate will keep in close touch with the officers of the Liverpool and Manchester City Councils and of the Sheffield and District Clean Air Committee, in order to ensure that they are aware of technological developments and of the standards required by the inspectorate elsewhere.

Industrial Films

New colour films featuring Appleby-Frodingham Steel Company and United Coke and Chemicals Company, Ltd., have been produced for The United Steel Companies, Ltd., by Wallace Productions, Ltd.

"Out of the Forest," which runs for thirty minutes, was filmed mainly at United Coke and Chemicals' Sheffield works, but also includes sequences shot at steel works, tar distilleries, and other locations. The company is primarily engaged in the carbonisation of coal to produce metallurgical coke, and the process is described in the film by an industrial chemist. The chemical derivatives from this process are also described, with the aid of models, diagrams and shots of actual production plant.

The second film, entitled "Stone into Steel," illustrates in broad outline the production of steel by Appleby-Frodingham Steel Company in Scunthorpe. The company, which is the largest single unit in the United Steel group, employs 11,000 people and produces 1,400,000 tons of steel a year. Five million tons of ironstone from the orefields of Lincolnshire and Northamptonshire are fed, after processing, into the company's four large blast-furnaces each year. As well as detailing the manufacturing processes involved in the production of steel, the film also studies the men who are responsible for its production.

Both of these films are in Eastmancolor, and are available in 16mm and 35mm sizes.

PERSONAL AND BUSINESS

Appointments

MR. J. S. WEBBER has joined Flow Developments, Ltd., as managing director.

MR. JOHN A. CARPENTER, A.M.I.Mech.E., has been appointed to the board of directors of Drysdale and Co., Ltd.

MR. IAN CAMERON, general manager of the Southampton works of John I. Thornycroft and Co., Ltd., has been appointed a director.

MR. H. C. R. TREWMAN, A.M.I.Mar.E., A.M.I.E.E., has been appointed marine sales specialist to Brush Electrical Engineering Company, Ltd.

MR. F. DRAKE PARKER has been appointed managing director and Mr. Douglas H. Carter, director and general manager of McKee Head Wrightson, Ltd.

THE M.O. VALVE COMPANY, Ltd., a subsidiary of The General Electric Company, Ltd., announces that Mr. J. Bell has been appointed a director of the company.

THE EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (C.E.R.N.) has announced the appointment of Mr. J. B. Adams as interim director of the Organisation.

SHORT BROTHERS AND HARLAND, Ltd., has announced the appointment of Mr. E. G. Collinson, A.F.R.Ae.S., as chief mechanical engineer to the company's aircraft division.

MR. T. C. HOWELL has joined Sperry Gyroscope Company's executive staff and has taken up the appointment of general sales manager of the industrial division, Brentford, Middlesex.

MR. H. H. UTLEY, A.M.I.Mech.E., has been appointed managing director of Davy and United Roll Foundry, Ltd. Mr. M. A. Fiennes, previously chairman and managing director, remains chairman.

MR. H. M. LONGRIDGE, chairman of the British Engine, Boiler and Electrical Insurance Company, Ltd., has relinquished that office, but remains a director. He has been succeeded as chairman by Mr. R. R. Mason.

TECALEMIT, Ltd., has announced the following appointments: Mr. T. R. Hardman, executive director (sales); Mr. H. E. Jackson, executive director (engineering); Mr. J. E. Drinkwater, executive director (production).

DR. J. BELL, manager of the Imperial Chemical Industries, Ltd., Nobel Division silicones department, has been appointed to the division board in succession to Mr. F. B. Wrightson, engineering and technical director, who retired on April 30.

HOLMAN BROTHERS, Ltd., announces that Mr. P. M. Holman, chairman and joint managing director, has relinquished his office of joint managing director on reaching the age of sixty-five, but remains on the board as chairman. Mr. J. F. Holman has been appointed managing director.

TARMAC, Ltd., announces that Mr. R. G. Martin has been appointed an additional vice-chairman of the company. Mr. S. W. Sangwin and Mr. G. R. Baxter have been appointed directors of Tarmac Roadstone, Ltd., and Mr. A. J. Loveland and Mr. C. E. Moore have been appointed directors of Tarmac Civil Engineering, Ltd.

THE NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS announces that Mr. J. B. Woodeson has been elected president, and Mr. R. Ibison as vice-president together with ordinary members of Council as follows: Mr. R. Atkinson; Dr. A. T. Bowden; Mr. N. Carter; Mr. J. Patton; Mr. R. J. W. Rudkin; Sir William Scott; Mr. H. P. Urwin; and Mr. W. F. Blackadder.

WILLIAMS AND JAMES (ENGINEERS), Ltd., announces that due to changes in its organisation the following staff appointments have been made: Mr. D. Lindsey, the company's sales manager, has been appointed general manager of Williams and James (Oil Tools), Ltd.; Mr. A. Gleave, chief engineer of Williams and James (Engineers), Ltd., has taken over the marketing organisation as general sales manager; Mr. P. A. Moffat, the company's test and development engineer, has been appointed deputy sales manager.

MR. GEORGE MORRISON, managing director of the Greenock Dockyard Company, Ltd., has been elected chairman of the Dry Dock Owners and Repairers Central Council for 1960-61. Mr. E. J. Hunter, chairman of Swan, Hunter and Wigham Richardson, Ltd., has been elected senior vice-chairman, and Mr. Richard Hill, a director of Charles Hill and Sons, Ltd., has been elected junior vice-chairman.

THE INTERNATIONAL NICKEL COMPANY OF CANADA, Ltd., announces that Mr. Richard A. Cabell, Mr. Albert P. Gagnebin, Mr. Ralph H. Waddington and Mr. James C. Parlee have been elected vice-presidents. Mr. John A. Marsh, vice-president of the company's United States subsidiary, The International Nickel Company Inc., has been elected to the further office of president of its Huntington alloy products division. Mr. Marsh has also been appointed a director of that company. Mr. Paul Queneau has been appointed technical assistant to the president of The International Nickel Company of Canada, Ltd.

Business Announcements

UDDEHOLM, Ltd., states that its London office has been moved to 78, Buckingham Gate, London, S.W.1 (telephone, Sullivan 2741).

FLOW DEVELOPMENTS, Ltd., has announced the establishment of a sales office at 6, Stanley Road, London, E.4 (telephone, Silverthorn 0550).

LOMOUNT VEHICLES AND ENGINEERING, Ltd., Colnbrook, Slough, Bucks, now manufactures the "Atlantic" series heavy tractors formerly known by the name of Rotinoff.

MR. RALPH CREDLAND has retired from the board of Widnes Foundry and Engineering Company, Ltd., after serving for sixty-two years with the Thos. W. Ward group of companies.

HAROLD BUTLER, Ltd., and ASSOCIATED ALFING KESSLER, Ltd., have moved from 254, Royal Exchange, Manchester, 2, to 63A, Alderley Road, Wilmslow, Cheshire (telephone, Wilmslow 5344).

MR. ARTHUR WHITELEY, assistant managing director, Massey-Ferguson (Export), Ltd., is to retire from the company on June 10 on reaching his sixtieth birthday, and on medical advice.

MASTABAR MINING EQUIPMENT COMPANY, Ltd., Accrington, Lancashire, has purchased Church Bank Mill, Church, New Accrington, East Lancashire, and will enter into occupation shortly.

MATBRO, Ltd., "Matbro Works," Horley, Surrey, states that James Bowen and Sons, Ltd., 45-59, Pitt Street, Edinburgh, 3, has been appointed sole agent for the sale and service of Matbro fork lift trucks in Scotland.

GLENFIELD AND KENNEDY, Ltd., Kilmarnock, Scotland, has concluded a licensing agreement with Schmitz and Schulte of Germany, and will shortly be in a position to supply S. and S. diaphragm valves to the United Kingdom and Commonwealth markets.

BAKER PERKINS, Ltd., Peterborough, announces an agreement with the German firms of Leonh Herbert and Paul Troester, allowing the British firm to manufacture and sell a complete range of rubber processing and moulding machinery previously made in Germany.

FIRTH CLEVELAND STEEL STRIP, Ltd., Tipton, a member of the Firth Cleveland Group, has concluded negotiations with the Steel Purchasing Organisation of the German Democratic Republic for the supply of specified tonnages of its "Fircleve" brand hardened and tempered steel strip for a period covering several years.

DUNLOP RUBBER AUSTRALIA, Ltd., and OLDHAM AND SON, Ltd., Manchester, announce that a jointly-owned sales company is to be set up in Australia under the title of Dunlop Oldham Pty., Ltd. The new company will market the Oldham PG double-sleeve tubular traction and other industrial batteries throughout Australia.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., for itself and on behalf of the Aluminum Company of America (A.L.C.O.A.), has made an offer for the issued share capital of Almin, Ltd., the parent company of the Associated Light Metal Industries Group, which has been accepted by over 90 per cent of the shareholders and is now unconditional.

THE SHIPBUILDING ADVISORY COMMITTEE OF THE MINISTRY OF TRANSPORT has set up a sub-committee whose terms of reference are "to review the prospects of, and the problems facing, the shipbuilding and ship-repairing industries and to make recommendations." It will report to the main committee.

ETHER LANGHAM THOMPSON, Ltd., has announced the formation of a new subsidiary company Ether Langham Thompson (Italiana), Ltd., Via Bisleri 19, Milano, which will manufacture and market products of the subsidiary companies, Ether, Ltd., J. Langham Thompson, Ltd., Electro Methods, Ltd., Datum Metal Products, Ltd., and Automation Systems and Controls, Ltd. Directors of the new company are: Mr. J. Langham Thompson, chairman; Dr. Bignardi and Dr. Scandola, joint managing directors; Mr. F. W. Coulling and Mr. F. B. Duncan.

BRISTOL SIDDELEY ENGINES, Ltd., announces a licence agreement with Piaggio and Co., of Genoa, for the manufacture and sale in Italy of the "Viper" 11 turbojet. This is the second agreement of this kind concluded by Bristol Siddeley with an Italian manufacturer—the "Orpheus" turbojet is already in production by Fiat, primarily for the Fiat G-91 strike fighter for the N.A.T.O. air forces. The "Viper" 11, which has a thrust of 2500 lb, powers the Macchi MB 326 which has been adopted by the Italian Air Force as its standard primary trainer: Piaggio will be supplying engines for this aircraft.

RIO TINTO MANAGEMENT SERVICES (U.K.), Ltd., Barrington House, 59, Gresham Street, London, E.C.2, announces that it has joined forces with the German metallurgical group, Deutsche Gold- und Silber-Scheideanstalt (Degussa) to form Nuklear-Chemie und-Metallurgie Gesellschaft m.b.H. (NUKEM). Mallinckrodt Chemical Works, through its subsidiary, Mallinckrodt Nuclear Corporation, is also a shareholder and has concluded a technical collaboration agreement with NUKEM providing for the exchange of information on the processing of nuclear fuel materials. NUKEM is to take over the existing research and production programme of the Degussa Nuklear Gruppe.

Contracts

THE COLLEGE OF AERONAUTICS at Cranfield in Bedfordshire has placed an order with Ferranti, Ltd., for a "Pegasus" digital computer; delivery is scheduled for July of this year. The computer will be made available to other organisations and firms locally who wish to use it.

Miscellanea

THE ROYAL AERONAUTICAL SOCIETY.—Because Sir Thomas Sopwith is indisposed the Inaugural Lecture of the Historical Group of the Society which was to have been given on May 17 (as announced on page 842 of this issue) has had to be postponed.

AUTOMOTIVE EXPORTS.—The April, 1960 *Monthly Statistical Review* of the Society of Motor Manufacturers and Traders, Ltd., includes a destination summary for the exports of automotive products from the United Kingdom during 1959. Cars amounted to (all figures in millions) £222·5, of which 40 per cent went to the Commonwealth and Empire or the Irish Republic; commercial vehicles to £89 (52 per cent); agricultural tractors to £65·5 (36 per cent); parts and accessories to £147·7 (47 per cent); i.c. engines up to 100 b.h.p. to £11·5 (38 per cent).

FLAMEPROOFED ENGINE.—A Perkins oil engine is now available in a form certificated for use in coal mines and other locations demanding flameproof equipment. It is the "Three 152 (Flame-proofed)," a variant of the P.3 (page 789, November 29, 1957) but with the thin, chromium-plated liners giving a swept volume of 152·7 cubic inches. It has a water-cooled exhaust manifold (the exhaust gas conditioner is supplied by the purchaser) and specially wide joint fairings on the cylinder head for mounting an induction flame trap; the cylinder block-to-head joint and the nozzle seatings have been redesigned. The engine is fitted in the Hunslet MT25 mines tractor, which is only 3ft wide over the wheels and 3ft 5in high. It is rated at 29 b.h.p. at 1650 r.p.m. (gross), with a maximum brake mean effective pressure of 97 lb per square inch at 1175 r.p.m.

CONTINENTAL AFFAIRS

by Our Continental Editor

German Industries Fair at Hanover

No. III—(*Concluded from page 797, May 6*)

AMONG the aircraft which were on show may be mentioned the Dornier "Do 28," the Morane-Saulnier "Paris," the Armstrong-Whitworth freighter "Argosy," the Focke-Wulf-built Piaggio aircraft FW-P149A, and several designs of helicopter. German airframe constructors were represented by Dornier, Flugzeug-Union Süd, and Focke-Wulf, among others.

Military aircraft on show included the F-104 "Starfighter" and the Fiat "G-91." The "Starfighter," which is to be used by the German, Dutch and Belgian air forces, is being built under licence by German aircraft firms in co-operation with works in Holland and Belgium. The "G-91" is also being produced under licence in the Federal Republic.

Gebr. Weyersberg

The use of polycarbonate and polyamide plastics for shrink-fit and expansion bushes was shown on the stand of Gebr. Weyersberg, Solingen-Ohligs. Such materials are claimed to give great concentricity with adjustable torque transmission, which acts as a safeguard, e.g. in the case of taper sleeves or parallel clamping sleeves for drills. Cylindrical workpieces with a central bore may be mounted on a taper mandrel by using the mandrel in conjunction with a suitable expanding bush inserted in the workpiece. A large number of other components embodying this principle are made by the firm, as well as drill bushes, and gland and sealing components for bolts and pipes.

Klockner-Humboldt-Deutz

At this year's Geman Industries Fair, Klöckner-Humboldt-Deutz A.G., Cologne, for the first time showed their "Model FL 310" air-cooled four-stroke diesel engine which is made in a single-cylinder and a two-cylinder version. With 85mm bore and 100mm stroke, at a speed of 3000 r.p.m. the engine develops 9·5 h.p. per cylinder. So as to keep this engine short and light it has been provided with vee-belt driven cooling blower. Our illustration (Fig. 13) shows the single-cylinder version of this engine. Remarkable for its low height is the "FM 716" vee-engine, built in versions with three, four, six and twelve cylinders. This engine has a bore of 135mm and a stroke of 160mm, and can operate at 2000 r.p.m. The turbo-charged twelve-cylinder version delivers a peak power of 340 h.p.

This firm has developed a small gas turbine, the "T16," an 80 h.p. unit weighing, with reduction gear, only 63 kg. The turbine is started with solid starter ignited by friction, and can operate at angles up to 30 deg. With suitable fuels and lubricants, it can be used at low temperatures down to −40 deg. Cent. For use for driving a fire pump, the turbine speed of 50,000 r.p.m. is stepped down to 4300 r.p.m.

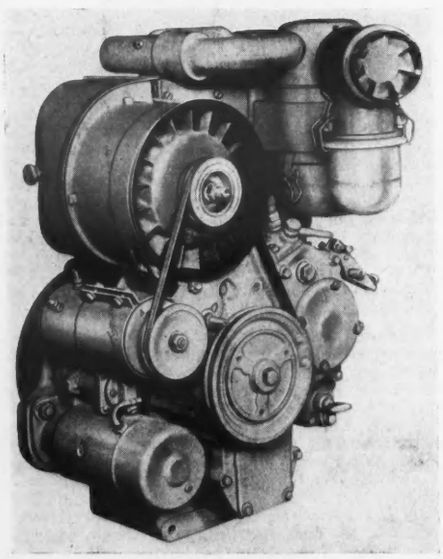


Fig. 13—"FL310" single-cylinder four-stroke air-cooled diesel engine

Bizerba

A very full cross-section of its production programme, which covers most aspects of industrial weighing, was shown by Bizerba Waagenfabrik, Balingen (Württ.). Our illustration (Fig. 14) shows a platform scale with a range of 24 kg and 20g scale divisions. This model is equipped with an electro-mechanical transducer which transfers the readings to a book-keeping machine which automatically writes down the figures on the invoice, taking into account unit price, adding up the individual items, and deducting from the total any rebates. At the side of the balance is a push-button panel from which the customer's reference number is signalled to the person making out the invoice, and at the same time the goods code number is directly printed on the invoice.

Another equipment on exhibition was a fully-automatic machine for calculating the price and printing the tickets for pre-packed goods.

Fig. 14—Balance with automatic transfer of reading-to-book-keeping machine for invoicing. The push-button panel transmits the code number of the weighed item to the book-keeping machine, and informs the operator of the customer's reference number

Sartorius-Werke A.G.

The "Electrono" electronic micro-balance made by Sartorius-Werke A.G., Göttingen, is designed to permit the rapid weighing of small amounts to an accuracy of 1 gamma (1×10^{-6} grammes). The principal advantage of the instrument is claimed to be not so much its great sensitivity, but the quickness of the weighing procedure.

The balance is available as a standard or as a vacuum model. In the latter case it is particularly convenient for evaporation studies; substances sensitive to air can be surrounded by a protective atmosphere to which other gases may be added to produce any partial pressure. One particular field of application of the micro-balance is in semiconductor technology for weighing the amounts of controlled impurities. The vacuum model lends itself to the determination of specific surface area, by weighing absorption layers. For the quantitative analysis of mixtures by evaporation or residue methods, it is possible to control sensitively both the temperature and the pressure. If a radiation screen is used to protect the balance, the scale pans may be subjected to temperatures up to 450 deg. Cent.

The balance, which can carry a maximum load of 1 gramme, is based on the principle of automatic compensation. The beam is suspended from tensioned ribbons; a small coil fixed to the beam moves in the field of high frequency coil and of a permanent magnet. This coil serves as position indicator and also to generate a compensating moment. The voltage from the coil is amplified by a transistorised amplifier, and fed back to compensate for the deflection of the balance. The current flowing, after full equilibrium has been established, is strictly proportional to the load, and can be indicated electrically or recorded.

VEREINIGTE ARMATUREN-GESELLSCHAFT M. B. H.

A full range of standard designs as well as new developments was seen on the stand of Vereinigte Armaturen-Gesellschaft m.b.H., Mannheim. With regard to the former, the company has now almost exclusively replaced cast iron with "Meehanite." Examples were shown of the "Elita" gate valve (in which foreign matter is prevented from entering the valve body by the continuous wiping contact between the gate and the seat skirts), and the "Flexi-Wedge" valve, in which perfect seating is maintained by adjustment of the wedge angle.

A novel design is the "Beta" gate valve for water mains (Fig. 15), which incorporates a rubber sealing ring. As the gate is screwed down, the ring is squeezed against the valve body all round its circumference, so that a perfect seal is obtained. It should be noted that the valve has no lower pocket in which deposits could accumulate.

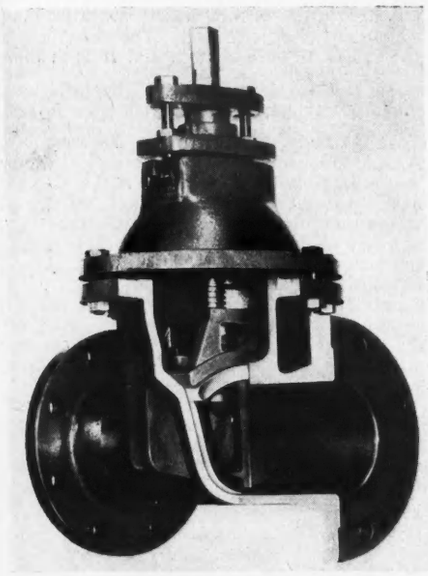


Fig. 15—Gate valve with compression rubber seal. The gate bottom is level with the pipe, preventing the accumulation of silt

RHEINISCHE STAHLWERKE, ESSEN

Examples from the many-sided production of the twenty-one companies constituting the Rheinische Stahlwerke concern were exhibited in the "Rheinstahl" pavilion and the surrounding open area. Among the important products shown we mention a large turbine gear wheel for a 77,000-ton tanker, forged in one piece from a 100-ton ingot by Ruhrstahl A.G., Hattingen. The ingot of electro-steel was degassed at Henrichshütte according to the Ruhrstahl-Heraeus process. Vacuum degassing of the molten steel is stated to improve its quality and also obviate the need for a lengthy annealing process which may take several months.

Rheinstahl Eisenwerke Gelsenkirchen A.G., Gelsenkirchen, exhibited continuously - cast pipes of up to 80cm diameter in lengths of 9m and 10m. Such pipes are made with special flexible connections which enable small curves to be achieved without the use of bends, and also withstand subsidence without fracturing.

A heat exchanger using thin steel wire as the transfer medium was shown by Vereinigte Economiser-Werke, G.m.b.H., Hilden. This exchanger is stated to achieve a four times greater heat transfer than former designs; some 50 square metres of heating surface can be contained in 1 cubic metre. For high pressures, the firm has developed cast iron economiser tubes with steel linings expanded to give full contact.

Rheinstahl Hanomag A.G., Hanover-Linden, has widened its programme of building machines. The "K65" loader (Fig. 16) has been equipped with a side-tipping bucket.

Rheinstahl Siegener Eisenbahnbedarf A.G., Dreis-Tiefenbach, exhibited a number of its special designs for improved road-rail transport without unloading. The "Seag" road transporter (Fig. 17) can carry railway wagons or other heavy goods with a total weight of up to 40 tonnes. The overall width is 2·5m, the axle pressure of the twin-tyred axles is 8 tonnes, and that of the single-tyred axles is 4 tonnes. The vehicle can negotiate curves with a minimum diameter of 6·5m. All articulated links are fitted with needle bearings. Wheel loads are transmitted by means of crank axles to hydro-pneumatic suspension cylinders rigidly mounted on the frame. The wheel loads within four groups of wheels are equalised whether travelling on level or uneven ground. The hydraulic system is coupled to a motor pump by way of a control valve which permits the ground clearance to be adjusted between zero and 380mm, while the sides of the vehicle can be raised or lowered independently.

The vehicle, which is fitted with pneumatic-hydraulic brakes, can attain speeds of 60km per hour without load.

The same company showed a goods wagon which, in addition to a light alloy sliding roof, has sliding walls of the same material so that convenient access is obtained with forklift trucks as well as cranes (Fig. 18). The wagon has a length over buffers of 14m, a platform of 33 square metres and a total volume of 86 cubic metres (75 cubic metres up to the top girders of the side walls).

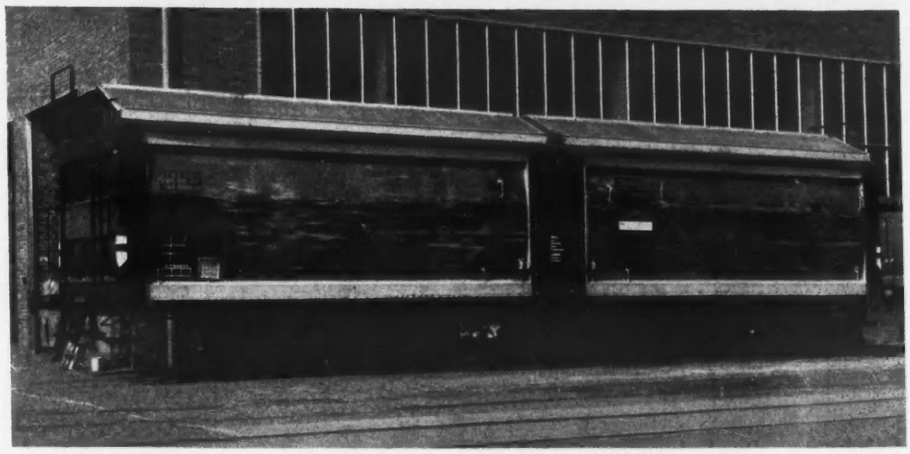


Fig. 18—Goods wagon with sliding roof and sides

GREIFZUG

For the safe lifting of loads such as sheets, tubes, sections, coils of wire, concrete pipes, &c., Greifzug Gesellschaft für Hebezeugbau m.b.H., Bergisch Gladbach, has produced the "Packan" hand grip. The lower jaw of this tool is flat or hooked, while the upper jaw possesses a point. As the lift is applied, the jaws apply a firm grip.

The company makes the well-known "Greifzug" hoist in which a wire rope is pulled straight through, without passing over pulleys, by an alternately gripping and releasing hand-lever operated mechanism. The same principle has now been applied in the "Seilknecht" tensioning device with which a pull of up to 1000 kg can

Fig. 16—Side-tipping power shovel

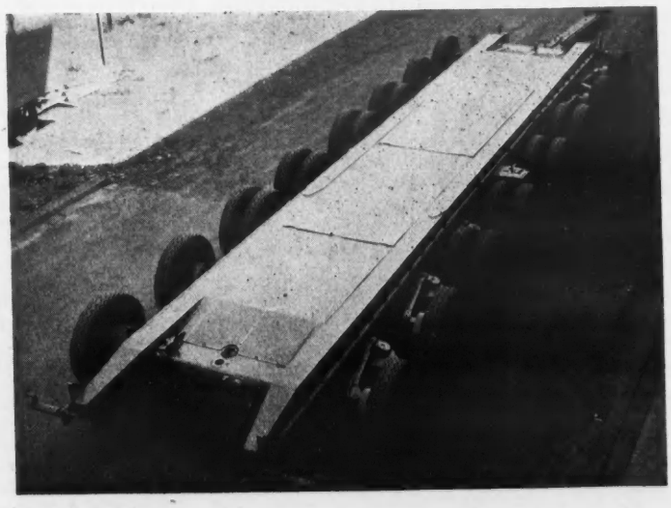


Fig. 17—Road transporter for railway wagons of up to 40 tonnes

CONTINENTAL AFFAIRS *(Continued)*

be exerted. The gripping jaws of the device are smooth, so that the wear of the wire rope is negligible ; the rope is inserted from the side, and can be of any length. By contrast with the "Greifzug," it is not possible to pay out rope under tension.

Mercedes-Benz

At the Mercedes-Benz stand, Daimler-Benz A.G., Stuttgart-Untertürkheim, showed its range of four-stroke industrial diesel engines of the

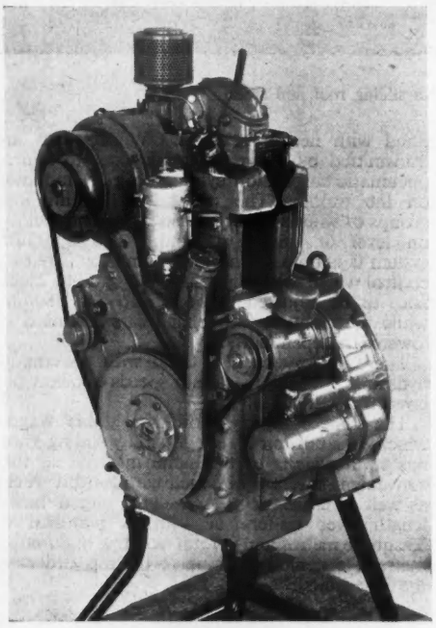


Fig. 19—Single-cylinder four-stroke diesel engine. This air-cooled engine has an output of 20 b.h.p. at 2000 r.p.m.

water-cooled "MB 850" series, and the air-cooled "MB 860" series. These engines, which are available in single-, two-, and three-cylinder versions, as well as a four-cylinder vee-design,

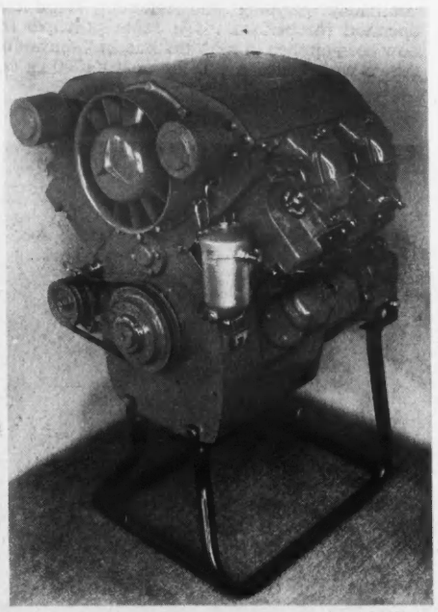


Fig. 20—Four-cylinder, four-stroke, air-cooled diesel engine, developing 80 b.h.p. at 2000 r.p.m.

have a maximum number of components in common. By way of illustration, we show the single-cylinder and four-cylinder air-cooled engines (Figs. 19 and 20). With a bore of 115mm and a stroke of 140mm, the single-cylinder engine develops 9 h.p. to 20 h.p. over a speed range of 1000 to 2000 r.p.m. Maximum effective pressure is 6·18 kg per square centimetre, and the compression ratio 1 : 18·5. At maximum output the volume of cooling air amounts to about 1000 cubic metres per hour, and the specific consumption to about 180 grammes per brake horsepower per hour.

Dr. Werner Herdieckerhoff

A high vacuum annealing furnace with pressure relieved liners was exhibited by the firm, Dr. Werner Herdieckerhoff Glühtopffabrik, Unna (Westf.). The basic principle of these vertical electric furnaces lies in the fact that the heater windings with their support structure and surrounding insulation are enclosed in an outer vacuum vessel in which the nickel-chromium steel container for the material which is to be annealed is centrally mounted. In this way the pressure inside the vacuum pot is kept equal to the surrounding pressure, so that the fatigue failures of earlier designs are avoided. A rotary piston pump maintains a pressure in the pot of 0·1mm Hg. The vacuum pot can be flooded with a neutral, reducing, or oxidising atmosphere, as required. It is stated that, owing to the even temperature distribution, the furnace is very suitable for the blueing of steel. For this purpose, any lubricants present are first evaporated, after which the oxidation is carried out at a higher temperature by means of pure oxygen.

Messier

An electro-pneumatic servo-motor for operating valves or other devices was shown by Messier, Montrouge (Seine). The motor comprises a solenoid-operated piston pump which directly drives the servo-cylinder, the sense of the movement being controlled by two electro-magnetic unloading valves. The whole mechanism is submerged in the oil tank which at the same time forms the casing. For the solenoid pump, single-phase current at 220V, 50 c/s is required, while the electro-magnetic valves work on 24V d.c. Should the current fail, the servo-motor returns under spring pressure to whichever end position is required. As an alternative, manual operation is possible. The servo responds to a signal within 0·03 second, the speed varying between 2mm and 0·5mm per second, depending upon the piston diameter, and the maximum effort between 260 kg and 1000 kg. The equipment is stated to be completely safe from fire and explosion.

Carl Zeiss

For the self-compensating level "Ni 2," Carl Zeiss, Oberkochen, has produced a stream-crossing equipment which eliminates residual instrument errors from the measurements, so as to obviate the necessity of interchanging the instruments on both banks and repeating the readings. The equipment consists of four "Ni 2" levels and two pairs of sighting discs. Two levels are placed on a common base plate on a single tripod on one side of the river or valley. After mutual collimation for which the inclination of the sighting lines is read, sights are obtained on the discs at the other side of the valley. The collimating ray of one instrument has the same inclination above the horizon as the ray of the other instrument has below, from which the level readings can be corrected ; an accuracy of 0·2 second, or 1mm difference in height over a total distance of 1km, is claimed.

A particle size analyser which can analyse 1000 particles in about fifteen minutes comprises an arrangement whereby the image of an iris diaphragm is projected on to a photograph of the particles. By means of a handwheel, the opening of the diaphragm is adjusted until the area of the circular image is estimated to be equal to the area of one of the particles. The turning of the handwheel at the same time operates a commutator, the divisions of which correspond to the size groups into which the particles are to be sorted. When the adjustment has been made, a foot switch is pressed which actuates an electric counter. The instrument has two ranges, 0·7mm to 9mm, and 2mm to 28mm.

Brown, Boveri and Cie

At the main stand of Brown, Boveri and Cie, A.G., Mannheim, one of the principal exhibits was a 1 : 50 full-scale model of a B.B.C.-Krupp high temperature nuclear power station. It will be recalled that a model of the reactor was shown by Krupp at last year's German Industries' Fair.* Last August, the Arbeitsgemeinschaft Versuchs-Reaktor (A.V.R.) G.m.b.H., Düsseldorf, a consortium of municipal electricity undertakings, placed an order with the B.B.C.-Krupp working group, and construction began on the site of the North Rhine-Westphalian research centre near Jülich.

With the Jülich reactor an attempt is being made to overcome the temperature limits imposed by metallic canning materials, by employing as fuel elements graphite spheres charged with uranium carbide. The core consists of about 82,500 spheres of 6cm dia-

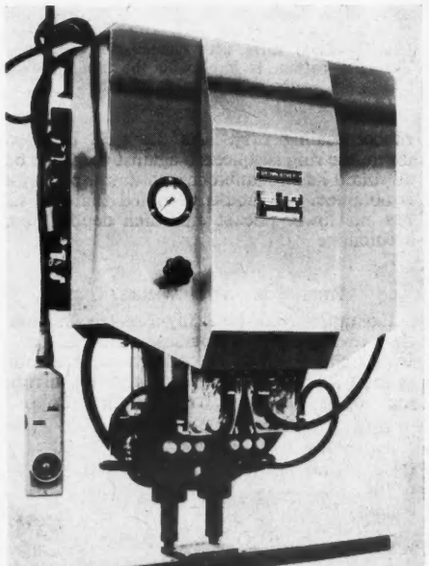


Fig. 21—Twin-spot welder

meter forming a heap of 3m diameter, and averaging a height of 2·2m.

Through this heap, helium or a helium-neon mixture is circulated and heated from 200 deg. to 850 deg. Cent. The cooling gas is used to raise 55·5 tons per hour of steam at 75 atmospheres and 505 deg. Cent. which is employed to generate 15MW of electricity. As the reactivity of the core decreases with increasing temperature, the reactor is inherently safe. Even a complete shedding of the load causes a comparatively minor increase in the core temperature on account of the large thermal capacity of the core assembly. The reactivity of the core can be controlled by adding or removing graphite

* See The Engineer, May 15, 1959, page 781.

spheres, and by varying the position of control rods.

The functioning of the reactor was illustrated by an illuminated display which demonstrated the principal phases : attainment of criticality by withdrawal of control rods ; attaining working temperature at zero load ; operating under partial and full load ; effect of shutting down the blowers ; shut-down of reactor. These phenomena were more accurately demonstrated by a simulator, in which the effect of the various parameters was shown on the screen of a cathode ray tube.

A high-frequency induction hardening machine with fully transistorised automatic control was demonstrated, for the hardening of cylindrical or conical workpieces of 750mm length and 35mm diameter, with an available power of 10kW at 1·5 Mc/s. The programme control of this machine gives a choice of three rotational speeds of the workpiece, and a continuous selection of the feed rate between 1mm and 60mm per second. At the same time, the high frequency power, quenching, and standstill times can be programmed in any order or singly operated.

In particular for workpieces of large area such as the walls of railways carriages, the twin spotwelder "PPD 10" (Fig. 21) which was shown at Hanover, was stated to have certain advantages on account of the fact that both electrodes are situated on the same side of the workpiece. At the opposite side there is a support inlaid with a copper conductor so as to provide a suitable path for the current on the underside of the workpiece. The machine has a high electrode pressure of 2×1000 kg at an air pressure of 5 atmospheres. The short welding times due to the use of a powerful transformer, and the high thermal conductivity of the support, are claimed to reduce temperature distortion to a minimum, while the flatness of the support prevents an impression of the welding spots from becoming visible on the underside, i.e. the outside of the finished workpiece. The spot welder is equipped with a transistorised programme control. The control unit is built up of a number of standardised miniature rack-mounting units. These elements have printed circuits and their components are embedded in resin and thus completely protected.

Heinrich Defries G.m.b.H.

The "Hadef-SSK" electric winch, produced by Heinrich Defries G.m.b.H., Düsseldorf, is made in five sizes from 2 to 12·5 tonnes capacity. The design is characterised by its self-supporting frame structure which completely encloses all the mechanical and electrical components, with the exception of the winch drum. A great measure of safety, as well as compactness, is achieved in this way. The fabricated drum can hold 400m to 500m of cable, depending on the model. Owing to the open horseshoe shape of the frame, the wire rope can stand off at any angle over a range of 290 deg. The gears are of cast steel and ground, and all journals are supported in ball bearings. The motor power ranges from 10·6kW in the smallest to 22kW in the largest model, the respective hoist speeds ranging from 37·5m to 11·45m per minute. An electro-hydraulic brake ensures smooth operation.

A.B. Åsbrink and Co.

A small pneumatic hammer for cleaning up welds, &c., was shown by A.B. Åsbrink and Co., Malmö. This hand tool acts as a picker as well as a blowing gun, and thereby supersedes the picker and wire brush generally used by the welder. Its air consumption is about 8·8 cubic feet per minute, the air pressure required being 86 lb per square inch. The hammer is 10·6in long and weighs 2·8 lb.

Industriewerk Schaeffler

Accuracy and a fine radial clearance are maintained by the "INA" adjustable needle bearing shown on the stand of Industriewerk Schaeffler, Herzogenaurach, near Nuremberg. This bearing is supplied with or without an inner race. The outer race possesses a number of deep circumferential grooves, the three grooves on the inside being staggered in relation to the two grooves on the external surface. The result in axial section is a meandering shape which provides two bearing surfaces for the needles. Under the effect of end pressure the bearing expands radially inwards, with a slight crowning of the bearing surfaces. As the adjustment is obtained entirely by means of the outer race, the inner race can be omitted, and in its place a hardened and ground shaft can be used, giving a high degree of accuracy together with a saving of space.

Elfried Mengel

A universal fly-cutter for use in drill presses has been put on the market by "Elmeso" Präzisions-Werkzeugfabrik Elfried Mengel, Solingen-M. The device allows circular holes to be cut from 35mm to 265mm diameter in materials ranging from metals and plastics to wood, rubber, glass and textiles. It incorporates four spring-loaded hold-down fingers adjustably mounted on radial arms.

A. G. Eisenhutte Prinz Rudolf

An automatic oxy-acetylene cutting machine developed by A. G. Eisenhütte Prinz Rudolf, Dülmen (Westf.) is designed for the preparation of pipes of 50mm to 350mm diameter, for the fabrication of straight or angled joints, and branches. The machine cuts out holes, as well as shaping the pipe ends, for all forms of equal and unequal branches, including offset branches and conical pipes, for included angles of 15 deg. to 90 deg. At the same time the cuts are bevelled at the angle required for the subsequent welding.

The machine comprises a base housing the variable speed drive, a large diameter hollow headstock spindle fitted with two self-centring chucks, and a sinusoidal gearbox for imparting the required axial movement to the burner carriage. An electric device, by rotating the inclined burner about a vertical axis, varies the angle of the cut so that the correct vee-shape is obtained when the pipes are assembled. The same device ensures a constant cutting speed. For each layout the geometrically correct movement is obtained by setting the sinusoidal gearbox, using tables or a special slide rule.

W. Hohenstein Sohne

A safety rope ladder was shown by W. Hohenstein Söhne, Duisburg. This device has rungs in the form of round (or square) hoops, supported by vertical ropes which are equally spaced around the circumference and thus form a sleeve. The workman or other user climbs inside the sleeve, which prevents his falling off should he lose his hold. A serious fall is claimed to be practically impossible. For getting in and out, lateral openings are provided. It is possible to extend the ladder by adding further lengths which are hooked on by bayonet or other couplings ; these also serve to attach the top end of the ladder. Additional ropes are drawn from the bottom rung to which they are attached over the top rung from which they hang down. By pulling the hanging length of rope, the ladder is pulled up and out of the way, its extended length of 8m being reduced to 0·6m to 0·7m. Over the upper carrier frame a protective cover is provided to keep off dust and dirt. The ladder rests on the lower closing flap of the cover which is released by a lever or push-button, when the ladder will fall out. The rope ladder is stated to be of advantage particularly in emergencies (fires, mine accidents, breakdowns on cable railways, &c.), but also in many instances where work is carried out at a height, such as erection of steelwork, crane driving and painting.

Verein Deutscher Ingenieure

This year's Annual Meeting of the Verein Deutscher Ingenieure will be held from May 16 until May 20 in Hamburg. The general theme "Production—the Realisation of Creative Thought" will be dealt with in some forty lectures which will be concerned with a cross-section from the most up-to-date technological and economic practice. Full information may be obtained from Abteilung Organisation des V.D.I., Düsseldorf, Prinz-Georg-Strasse 77-79 (telephone, 443351, extension 258).

From May 4 until May 6, the V.D.I. Dust Technology Section, Düsseldorf, met in Vienna. The conference was organised in collaboration with the Osterreichischer Ingenieur-und Architekten-Verein and the Osterreische Staub - (Silikose -) Bekämpfungsstelle, Vienna. Meetings dealt with development tendencies in the field of dust measurement.

During the same period, an International symposium on Distillation was held in Brighton. This was organised by the Verfahrenstechnische Gesellschaft im V.D.I., Frankfurt/Main.

British Jet Detuner at Zurich

Swissair's technical department at Zurich Airport has recently taken delivery of a jet detuner made by Cullum Detuners, Ltd., of London. It was transported to Zurich from Rotterdam by road and rail in thirteen segments.

The detuner, which is 100ft long and weighs 56 tons, has now been installed in the engine

Filter element of jet detuner being hoisted into position

test house of Swissair at Zurich Airport, in the second cell reserved for jet turbine testing. The detuner is so large that it projects almost 50ft from the building.

Jet noise immediately behind the engine exhaust has an intensity of about 160 dB above the audible threshold. The detuner reduces this by 60 dB, leaving a noise volume corresponding approximately to that caused by a large lorry.

Italian Machine Tool Exhibition

The "B.I. M.U. 1960" Italian Biennial Machine Tool Exhibition will take place in Milan during the period October 7 to 16, on the grounds of the Milan International Trade Fair. The exhibition will be concerned with all classes of machine tools and many kinds of ancillary equipment and plant. Foreign firms will participate through their Italian representatives. Full information may be obtained from the Unione Costruttori Italiani Macchine Utensili (U.C.I.M.U.), Via Palestro 22, Milan.

THE AMERICAN SCENE

by Our American Editor

Manufacture of Impact Extruded Aluminium Beer Cans

After four years of intensive development and an investment of 1,000,000 *dollars, the Adolph Coors Company brewery, of Golden, Colorado, is now producing an impact extruded aluminium beer can that actually costs less than a similar can made of tin plate. This accomplishment represents the first successful " captive " aluminium can-making operation in the United States, and indicates an impending invasion of one of the biggest potential markets by aluminium.*

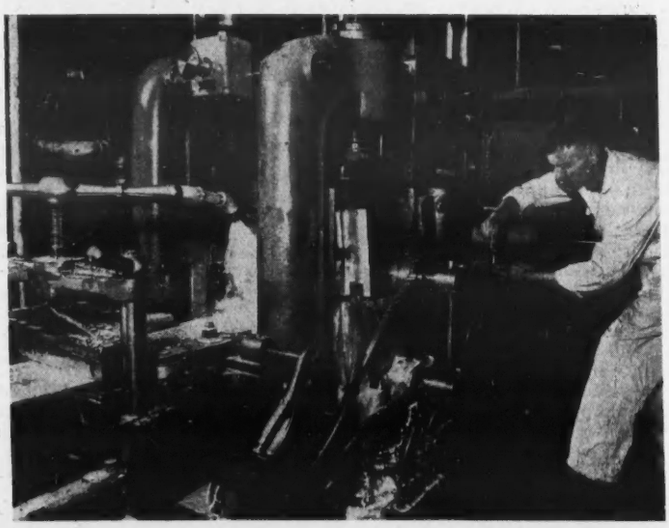
THE new integrated aluminium beer can manufacturing operation at the Golden brewery in Colorado of the Adolph Coors Company constitutes an important forward step in the field of impact extruded can application. The Coors development is significant, not for the number of aluminium cans produced, but because it proved that the aluminium can is both technologically feasible and economically practical in the United States. Of the many factors that stimulated the firm's initial interest in aluminium cans, perhaps the most important ones concerned the company's marketing area, the chemical reaction between beer and tin plate, and the problem of disposing of used beer cans. Coors sells its beer in a sparsely settled area covering almost half of the United States, but containing less than 10 per cent of the population. Rapid turnover is difficult in this area so that the firm has to be more concerned about the shelf life of its beer than is the average brewer. Much of the trading area is in the hot south-west, where temperature aggravates the shelf-life problem. Coors had found that there is no can interior so protectively coated that the beer will not pick up tin and iron as it sits on the shelf, whereas the aluminium can largely overcomes these shortcomings of the tin can. Finally, Coors, like other brewers, is deeply concerned about what happens to used beer cans. All too often they end up on the highway or littering the park or beach. Organisations that favour the return of prohibition take particular delight in blaming brewers for the litter. The firm, therefore, reasoned that an aluminium can might have sufficient scrap value to encourage consumers to return the cans for cash.

In 1955 the brewery decided to enter the aluminium can field, using the impact extrusion process, and a subsidiary company, Aluminum International, Incorporated, was set up for this purpose. The starting material for impact extrusion is a slug of aluminium about the same diameter as the can to be produced and about $\frac{1}{4}$in thick. Aluminum International could have bought slugs on the open market, but five years ago the going price for slugs was about equal to the firm's costs for making the whole can. Three years of development work finally created an efficient continuous casting, rolling and slug blanking installation that brought down the cost of slugs. Though crude in appearance, it was so successful that when some of the large aluminium producers and fabricators realised its potential, they dropped the price of slugs so low that the company can now buy them for less than it can make them. The low-cost slug puts the impact extruded can well within the reach of anyone who wants to enter this field now. Aluminum International encountered similar problems with can lids. The first price quoted by an outside supplier nearly equalled the combined cost of can and lid that Coors was aiming for. Later bids were still about 50 per cent too high, so that the firm soon found itself rolling its own aluminium strip down to proper gauge for lids and punching them out.

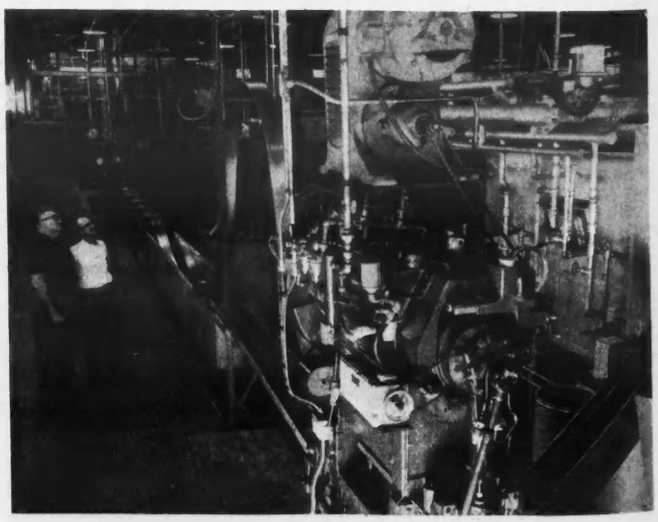
At the starting point of the production line, 50 lb pigs of 1100 aluminium alloy are melted in a 450kW Ajax-Magnethermic low-frequency induction furnace. The melting capacity of this unit is 2000 lb of aluminium per hour ; its holding capacity is 6000 lb. The furnace melts an average of 5 to 6 tons per shift, and with two shifts a day and a five-day work week, from 50 to 60 tons of aluminium are converted per week. The metal is held at 1280 deg. to 1320 deg. Fah. and fed across a launder to the Porterfield-Coors continuous casting machine, which operates on the rotary wheel principle similar to that used by the Rigamonti process. A continuous mould is formed between the machined channel in the revolving wheel and a continuously moving endless steel belt. Both the wheel and the belt are water cooled. As molten metal flows down through a specially designed spout into this water-cooled mould it is chilled and solidified instantly. The resultant bar, which measures 6·5in wide and 0·700in thick, emerges continuously from the bottom of the machine at a rate of 10ft to 12ft per minute.

The bar of aluminium travels through a slack loop end and then passes between the rolls of a hot mill which reduces its thickness to about 0·200in in one pass. The bar enters the mill at a temperature of about 900 deg. Fah., leaves at about 25ft per minute, is quenched to 100 deg. Fah., and then passes through the cold mill, which reduces it to a final thickness of 0·125in. From here, the strip passes through a flying shear and a roller leveller into a kerosene bath which removes any residual rolling oil and deposits a thin film of lubricant. It then travels through another slack loop and into the Bliss high-speed blanking press.

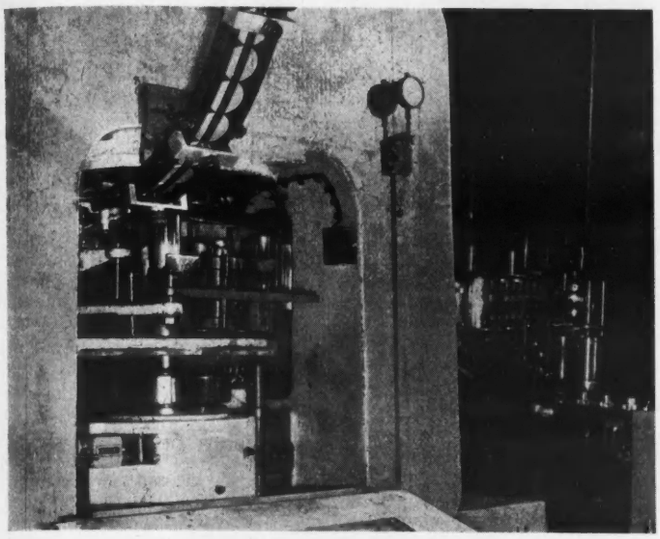
The 60-ton press punches out three slugs per stroke at a rate of 300 per minute. The actual output is 230 slugs per minute due to down-time on the press to allow the slack loop to build up. The operation of the press is synchronised with the movement of the slab by an automatic control of the slack loop. From the blanking press the slugs are carried by chain conveyor into a Despatch gas-fired furnace which anneals them at 800 deg. Fah. for one-and-a-half hours. The annealed slugs are then air cooled. At this



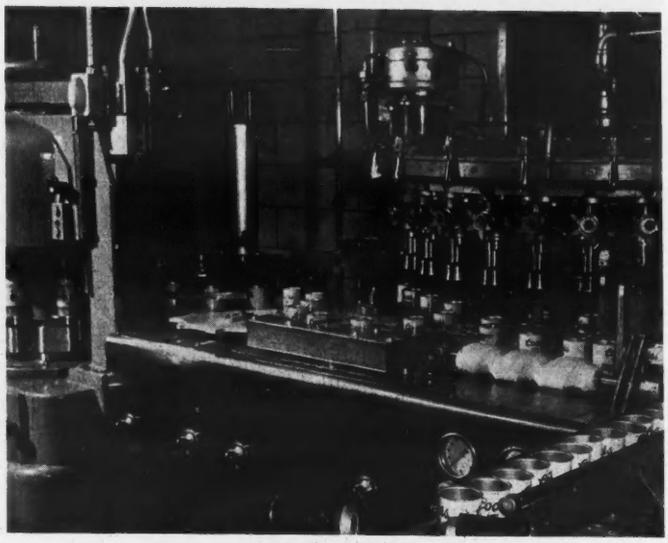
Final reduction of 6½in wide continuously cast aluminium strip to ¼in thickness in two-high cold rolling mill



Automatic impact extrusion slug production line, with rolling mills in background and cleaning tank and blanking press in foreground



Feeding of slugs into one of the two Herlan 400-ton impact extrusion presses having a capacity of 3600 cans per day



Filling and closing of cans in a hermetically sealed room and an atmosphere of sterile air, to eliminate pasteurisation

point the continuous operation is interrupted. Cleaning, deburring and lubricating of slugs is done by batch methods at present. Soon to be installed, however, is a new Almco automatic washer and tumbler which was specially designed and built to Coors' requirements. When this component is integrated into the line, annealed slugs will be conveyed to a hopper atop the machine. A device will then meter out a certain weight of slugs and dump them into the barrel. From there the machine will automatically perform several operations, including washing, deburring, drying, applying wax lubricant, and drying. At this point the slugs will be ready to be either packed and shipped or conveyed directly to the impact extrusion presses.

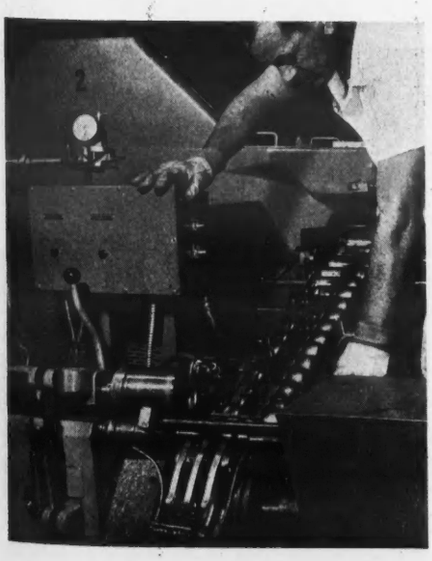
The production of can bodies is handled by two Herlan 400-ton horizontal impact extrusion presses. The slugs are dumped into a hopper, from which they are fed automatically into the die cavity of each press. Each stroke of the press punch converts a slug into a can body, which is then fed directly into a Herlan rotary trimming and flanging machine. The can bodies are fed automatically to a spindle conveyor which carries them through a four-stage washing, etching and drying machine. The etch cleaning compound used here removes the extrusion lubricant and conditions the aluminium surface so that it will accept printing inks on the outside and a special vinyl lacquer on the inside. The can bodies emerge from the washer completely dry and are transferred automatically to a cylindrical offset press which applies the Coors four-colour printed design and a clear lacquer overcoat. This German printing press was designed to print one can with each revolution of the drum, but the firm retooled it to handle four cans per stroke.

As they come off the press, the decorated cans are transferred on to a peg chain conveyor which carries them through a drying oven. After an eight-minute travel through the oven they are transferred automatically to the internal coater which applies a vinyl film over the entire interior of the can. A twenty-minute travel through another oven cures the vinyl coating, after which the cans are ready to be packed and shipped to the brewery.

The production of lids also begins at the continuous casting-rolling line. As the cast and rolled slab emerges from the cold mill, it can by-pass the leveller and proceed directly into the coiler which produces a 600 lb to 700 lb coil of stock. These coils are annealed in a Lindberg batch oven and then cold rolled down to 0·0145in thick lid stock. The coiled lid stock is washed, given a coating of wax and then fed into one of the two lid blanking and forming presses. One stroke of the press blanks two pieces at a time, forming them into domed and flanged lids. Subsequent operations apply a latex sealing compound to the rim of the lid and cure the latex in a conveyor oven. The sterile lids are then packed and shipped to the brewery.

The line at present produces aluminium cans at a rate of 110 per minute. The limiting factor is not in melting, casting, rolling, processing of slugs, impact extruding or printing, but in the transfer mechanism to the printing press. The can itself holds seven fluid ounces, compared with the 12 oz capacity of the conventional American beer can. The trimmed and flanged can body is 4·281in high and 2·102in in diameter. It has a 0·0118in thick wall and a 0·025in thick bottom and weighs 18·3 grammes. The lid is 0·0145in thick and weighs 3·9 grammes. The plant obtains about twenty can bodies per pound of aluminium melted. Another pound of metal yields about seventy can lids. Thus, allowing for scrap, the plant is presently producing up to 100,000 cans per day in two shifts.

The company is about to put into production a new can line which will include two new extrusion presses, faster transfer mechanisms, a new printing press, a new slug cleaning, deburring and lubricating equipment, and other items. The new impact extrusion presses are designed to turn out aluminium cans at a 120 per minute rate, about twice as fast as existing presses of



Passage of extruded cans through the Herlan rotary trimming and flanging machine

Four-colour printing of aluminium cans on Alfons Mall cylindrical offset lithography press

THE AMERICAN SCENE *(Continued)*

equal size. The new presses and the faster transfer mechanisms will give the new line a capacity of 250 to 300 cans per minute. In addition, the present line will be accelerated to run at 140 cans per minute. From the outset, once the firm had committed itself to the idea that the aluminium can must be competitive with the tin plate can, it had to be able to make it for what it could pay for a comparable conventional can.

The economic success of the installation is considered to be due to the low labour cost of only five operators on the can line and the low pig-to-slugs conversion cost. The latter may be improved further to about 3 cents per pound once the continuous casting-rolling line is operated at the rate of 5000 lb per hour.

The company fully realises that with all its attributes, the aluminium can has one serious drawback : it is extremely delicate, difficult to handle, and hard to fill. It is much more confident of its ability to make the cans at speeds of 400 per minute than to fill them at this speed. But the filling problem has now been solved and the brewery is increasing the aseptic filling speed to 400 per minute from the present 130 per minute. The aseptic filling of the standard 12 oz can will be more difficult, but the can plant seems to be moving in the direction of producing this size of container in aluminium.

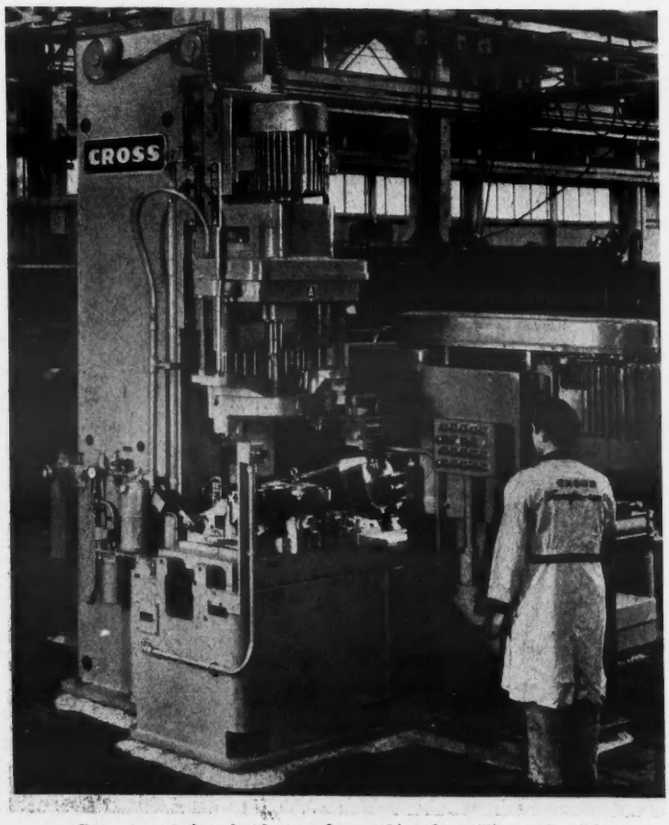
With the success of the aluminium beer can established, the Coors can plant is now tooling up to produce aluminium aerosol containers. It has obtained a licence to make standard 3 oz, 6 oz and 12 oz aerosol cans by the Italian Bombrini Parodi-Delfino process. The body will be impact extruded and the dome and neck will be formed by a twelve-stage drawing and ironing operation. The equipment will handle twelve cans at once, turning out one complete unit with each stroke. The line speed is scheduled at 100 per minute initially, with 250 per minute being the ultimate aim.

Cross Shuttle Transfer Machine for Exhaust Manifolds

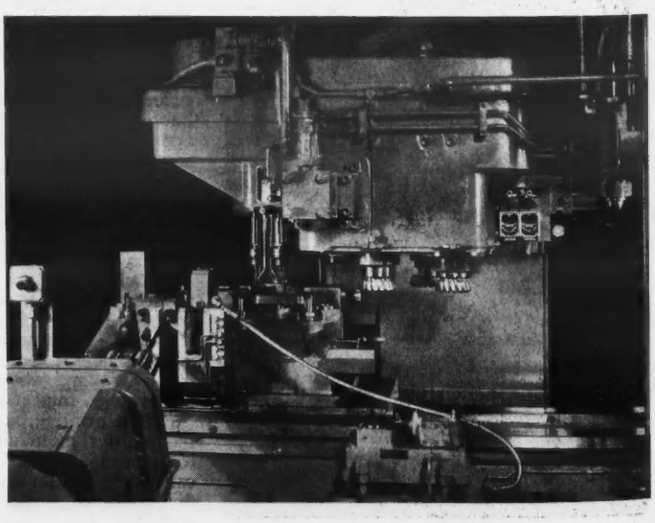
EXHAUST manifold castings can now be completely finished in a machine that not only saves floor space but permits simple alterations to meet changes in part design. Designed and built by the Cross Company, of Detroit, Michigan, this machine mills all flange faces of manifolds while they are being transferred and does machining operations in both stations. Any change of the tailpipe flange angle, which usually changes with each new vehicle model, can be accommodated by changing the fixturing and the angle of just one head in one of the stations. A two-position fixture, mounted on the shuttle, is loaded with two parts in the first station. One raw casting is clamped with the four exhaust port flanges up. A partially finished casting is turned end for end, rotated approximately 90 deg., and clamped with the tailpipe flange up. The fixture locates the unmachined part on cast surfaces and will accommodate normal casting variations. The semi-finished part is located by two milled surfaces and two drilled holes.

After the automatic cycle is initiated, the pallet moves to the second station. During the transfer, the parts pass under and are machined by three inserted-blade carbide-tipped milling cutters. The exhaust port flanges pass under a roughing and a finishing cutter. Only one cutter is needed on the tailpipe flange since finish requirements here are not as rigid because the tailpipe fits into a machined opening, directing the hot gases away from the gasketed joint. In the second station, the tailpipe flange holes of the raw casting are drilled by an angular head. The same holes in the semi-finished part are tapped by tools mounted on the same short vertical column as the milling cutters. With normal design changes, it would only be necessary to change the angle of the tailpipe flange-drilling head.

The parts are shuttled back to the first station in rapid traverse for the final machining operations. To prevent scuffing of the milled surfaces, the milling cutters are lifted about $\frac{1}{8}$in during the period of the return movement. In this station, the eight exhaust port flange holes of the raw castings are drilled and the central opening in the tailpipe flange of the semi-finished part is finished with a two-step boring tool using carbide cutters. At the end of this automatic cycle, the operator removes the finished part, transfers the semi-finished part to the second fixture position and inserts a raw part in the first position. Each back-and-forth cycle of this machine produces one finished manifold, and the production rate is twenty parts per hour "at 100 per cent efficiency."



Cross two-station shuttle transfer machine for milling and drilling exhaust manifold castings



Second station of transfer machine, with angular drilling head and vertical tapping head

Data Processing for Business

WITH the introduction of two new electronic data processing systems, the Radio Corporation of America has claimed to be the first company to offer a complete range of electronic computer service, basic and peripheral equipment for businesses of every size. Announcement of the systems was made over a closed circuit television network linking thirteen cities. One of the systems, the 301, is designed to provide full-scale data processing for small firms. The store consists of magnetic discs, similar to 45 r.p.m. records, or magnetic tape may be used. Like the tape, the discs may be erased and reused many times. The 301 can serve as a complete data processing system or as an auxiliary to the larger 501 and 601 systems. In the latter capacity it can be used as a tape-to-card converter, off-line high-speed printer, or paper tape to magnetic tape converter. Its store can include five disc file units, each holding 5,000,000 characters, and up to twelve tape stations, each holding 4,000,000 characters.

The second system, the 601, is claimed to offer more work power than any data processing system now available and to be the world's fastest business computer. Access time to the memory is 1·5 microseconds. The system is of a modular design which enables a great variety and volume of work to be accomplished by plugging in additional modules, and this interchangeability of parts also enables the computer to be modified in line with new developments. Another advantage of the modular design is that programming of the 601 is compatible with that of any other data processing equipment. It can be provided with instruction control units able to take instructions from units of any kind and to feed the data directly to the 601.

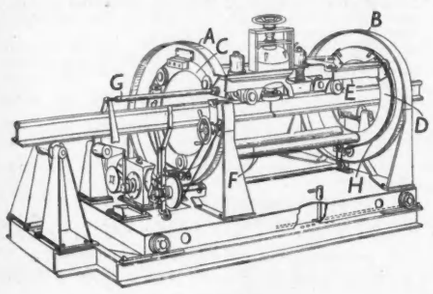
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

RAILWAY EQUIPMENT

831,652. August 10, 1956.—GRINDING MACHINE FOR RAILS, BEAMS, &C., Materiel Industriel S.A., No. 2 Grand Pont, Lausanne, Switzerland, and Constructions Mecaniques S.A. Renens, No. 33, Rue Neuve, Renens (Canton de Vaud), Switzerland. (*Inventor : Hermann Ackermann.*)

Referring to the drawing the rail head grinding



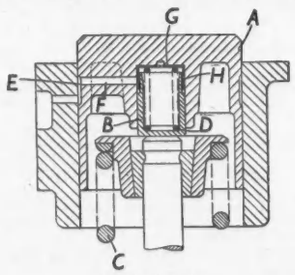
No. 831,652

mechanism comprises a fixed base with a roller-mounted bed and separate pedestals which support rollers on which the rail to be ground rests and travels. The rail passes through two rings *A* and *B* mounted on the bed. Within each of these rings is rotatably carried another ring. These two inner rings *C* and *D* are connected by longitudinal guideways *E* and two heavy bars *F* which serve as counter-weights for a carriage which travels between and along guideways. This carriage bears a motor driving a grinding wheel which is used to grind weld seam from the rail. For moving the carriage back and forth across the weld seam there is provided a connecting rod *G* which is reciprocated by means of levers. To effect the movement of the carriage circumferentially over the profile of the rail head, a chain *H* drives the ring *D* and its coupled ring *C* within the rings *A* and *B*.—*March* 30, 1960.

INTERNAL COMBUSTION ENGINES

831,984. November 5, 1957.—SELF-ADJUSTING TAPPETS FOR VALVE GEAR, Engineering Research and Application, Ltd., formerly known as English Racing Automobiles, Ltd., London Road, Dunstable, Bedfordshire. (*Inventor : Cormac Garrett O'Neill.*)

This invention relates to tappets which are known in the trade as "inverted pot" cam followers. A form of the invention is described with reference to the accompanying drawing, in which the valve is of flexible non-return design of inverted pot-shape. The inverted pot *A* has an internal central boss with an axial cylindrical bore. In the bore slides a hollow plunger *B* with an oil clearance of about one-thousandth of an inch, and which is closed at its lower end. A spring *C* loads the valve against its



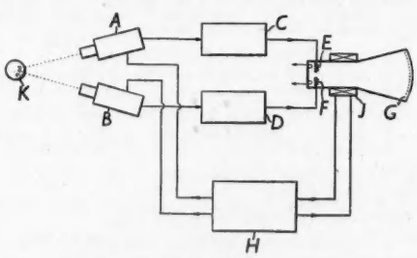
No. 831,984

seat in the cylinder head through the usual collar and collets. The plunger *B* is maintained in contact with the end of the valve stem by a light spring *D* between the plunger and the inverted pot. During the opening period of the valve, however, the load of the valve spring *C*, and all inertia loadings due to acceleration of the valve masses, is carried by the plunger *B* since during this period the valve is lifted clear of the valve seat by the action of the cam and the hydraulic tappet assembly. An annular groove *E* around the pot, a short distance from the upper surface, communicates with one or more supply channels *F* which lead to its central bore. The upper end of the plunger is of reduced diameter and an annular cavity *H* is formed between this part and a nylon valve *G* which has a flexible wall between five to fifteen thousandths of an inch thick. The length of the nylon valve is at least two-thirds of the length of the relieved portion of the plunger, so that the cavity is in communication with the bore. The nylon valve is held in position by the spring *D* within the plunger, the cylindrical sides of the valve being in effect hinged to the flat top of the pot-shaped valve. The nylon valve covers the supply channel *F* entry into the bore. The operation of this self-adjusting tappet is as follows : when the valve is closed, the annular groove *E* is charged with pressure oil from the engine and oil, fed through the radial channel *F*, opens the nylon valve and flows into the cavity *H* and the chamber within the plunger. As the camshaft rotates, the tappet moves down and compresses both the light spring *D* and the oil within the cavity *H* and the plunger bore. The oil pressure holds the nylon valve firmly against the channel openings so that the force exerted by the oil moves the plunger *B* down and in this way opens the engine valve. The supply channel may be shut off by the pot as it moves down. As the camshaft continues to rotate, the non-lifting part of the cam is reached and at this point, due to the small loss of oil occurring during the lifting period, a small degree of vacuum will occur in the plunger bore, due to the action of the spring. Under these conditions, the oil supply pressure to the tappet will exceed the pressure in the volume within the cavity *H* and oil under a pressure of, say, 10 lb per square inch, will flow past the nylon valve to replace the oil lost and to take up the tappet clearances. If there is some ingress of air to the cavity it is compressed on the following stroke, and forced between the bore and the plunger and thereby removed with the leakage of oil.—*April* 6, 1960.

ELECTRONICS

831,630. December 20, 1957.—STEREOSCOPIC TELEVISION, Standard Telephones and Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2. (Assignees of John O. Silvey and Sidney B. Hargreaves, Jnr.)

An object of this invention is to provide an electronic television system for presenting a stereoscopic image with reduced flicker, the received images being displayed continuously and simultaneously as contrasted with previous sequential displays. Referring to the drawing, cameras *A* and *B* preferably are



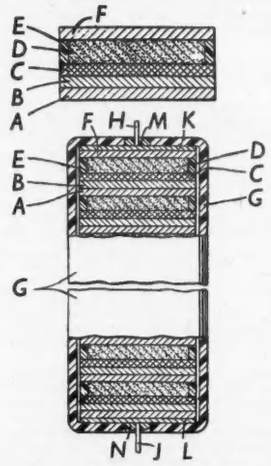
No. 831,630

identical and are conventional in design. The video signal is coupled from the output circuit of each camera into respective amplifiers *C* and *D* which amplify the respective signals for application to two of the control grids *E* and *F* of a colour television display tube of the type commonly used in colour television receivers. On the front face of the tube is provided the usual phosphor dot triads disposed in registry with masking apertures in the shadow mask *G*. This conventional colour tube utilises three electron guns but here only the red and green guns are used. Thus the tube is capable of producing two different images, one in green and the other in red. Common synchronising and deflection circuits *H* are coupled to both cameras and the deflection yoke *J* of the display tube. In operation, the two cameras are focused upon the object or scene *K* thereby producing video signals which represent the slightly different viewpoints. These two signals are amplified and applied to the control grids and of the red and green electron guns, respectively. The electron beams produced by these two guns are scanned over the shadow mask in the uusal manner, passing through the apertures in the shadow mask at the proper angle for striking the respective colour phosphor dots. Thus, the red gun produces a red image on the display screen whereas the green gun produces a green image. Since these two images correspond identically to the scenes viewed by the two cameras, they will be offset slightly from each other on the display screen. Viewing this display screen through spectacles having red and green lenses results in the viewer seeing a black and yellow image in perspective. Since the presentation of the two images is substantially continuous and simultaneous, there is a considerable reduction in flicker over that experienced with prior systems. The display screen may be viewed from different angles without destroying the stereoscopic effect ; and the images are perfectly registered, since the display tube presents exactly the scenes which are viewed by the two cameras. It is thus possible for many people to view the display screen simultaneously, each person seeing essentially the same stereoscopic image.—*March* 30, 1960.

ELECTRIC BATTERIES

831,060. January 23, 1957.—PRIMARY ELECTRIC CELLS, Union Carbide Corporation, 30, East 42nd Street, New York, State of New York, United States of America.

According to this invention there is provided a primary cell comprising a silver anode, a cathode collector of stainless or ferritic chromium steel, a solid silver iodide electrolyte and a depolarising oxide comprising an oxide of a polyvalent metal in higher valency state. In the construction of the invention the cathode collector of one cell is adjacent to and in contact with the anode of another cell. Referring to the upper drawing, a member *A* of



No. 831,060

austenitic chromium-nickel steel (which may serve as the cathode collector of a cell in juxtaposition with the cell to be described) has a layer *B* of silver thereon and preferably united thereto. On the silver layer is a layer of silver iodide, *C*. Adjacent to the silver iodide layer, and in contact therewith, is a cathode mix *D* comprising metal oxide depolariser and finely-divided, inert, electrically conductive material such as micronised graphite or acetylene black. The mix is of lesser width than the elements already described. It is bounded by and supported laterally by a ring or frame, *E*, of electrically insulating synthetic resin. Adjacent to, and in contact with the upper surface of the cathode mix, is a cathode collector, *F*, of the same material as the member *A* and adjacent to which may be the anode of another cell. Cells of this construction may be assembled in series to form a battery, as shown in the second drawing, wherein the cells are stacked and encased in a container, *G*, such as an electrically insulating synthetic resin. Electrical contact may be provided to the cell by conductors *H*, *J*, secured to end plates *K*, *L*, through sealed apertures *M*, *N*. A method of manufacture is described which enables the cells to be extremely thin, for instance, the thickness of the silver iodide electrolyte averages about 15 microns. The initial voltage of cells manufactured in accordance with this invention averages about 0·455V and after storage for one month at 73 deg. Cent., the voltage of such cells averages 0·449V. The cells are so thin that batteries may be produced having voltages above 40V per centimetre. —*March* 23, 1960.

AIRCRAFT

832,181. February 17, 1954.—AEROPLANES, Vickers-Armstrongs (Aircraft), Ltd., Vickers House, Broadway, Westminster, London, S.W.1. (*Inventor : Barnes Neville Wallis.*)

This invention is concerned with aeroplanes in which the wings are pivotally movable in relation to the body so that they may be set in a transversely spread position during take-off, landing and low-speed flight, and moved into a swept-aft position for high-speed flight. In certain cases it is necessary, in order that the wings may assume the swept aft position, to provide in the sides of the body pockets or cavities adapted to receive parts of the wing which, in the low-speed position, are situated in the region of the trailing edge. Although when the wings are fully trailed, these parts may be arranged to fit snugly against the walls of the pockets, it is contemplated that certain conditions of flight will require their adjustment to an attitude somewhat short of the trailed position. The object of the invention is to provide in such cases means whereby the wings are sustained against flutter when they lack the rigid support which, when fully retracted, would be afforded by the structure of the pockets by which they are then partly enclosed. The specification illustrates means whereby the edges of the wing pockets in the body are fitted with oppositely disposed resilient cushions, the spacing between which is self-accommodating to the instantaneous thickness of those parts of the wings which lie between them. Automatic adjustment of pressure in the cushions will make them capable of exerting sufficient pressure on the wing surfaces to sustain them firmly against flutter.—*April* 6, 1960.

Catalogues and Brochures

W. G. PYE AND CO., Ltd., Granta Works, Cambridge.—Scientific instrument catalogue.

GEORGE PIKE, Ltd., Equipment Works, Alma Street, Birmingham, 6.—Leaflet describing the "Kwikform" road barrier.

TOUGH PLASTICS, Ltd., Byfleet Road, Addlestone, Surrey.—Illustrated brochure describing the company's plastic fabrication services.

MEGATOR PUMPS AND COMPRESSORS, Ltd., 43, Berkeley Square, London, W.1.—Illustrated folder describing a range of marine fire pumps.

ROYAL WORCESTER INDUSTRIAL CERAMICS, Ltd., Tonyrefail, Glamorgan.—Booklet describing "Regalox" high alumina ceramic material.

SURRIDGE'S PATENTS, Ltd., Croydon Road, Beckenham, Kent.—Illustrated brochure giving details of the company's industrial adhesives.

HENRY WIGGIN AND CO., Ltd., Thames House, Millbank, London, S.W.1.—A new edition of the handbook "Welding, Brazing and Soldering of Wiggin High-Nickel Alloys."

C. S. JOHNSON COMPANY (subsidiary of Koehring Company), P.O. Box 71, Champaign, Illinois-Stockton, California.—Brochure giving details of concrete mixers available in capacities of 2 to 7½ cubic yards.

KOEHRING COMPANY, 3026, West Concordia Avenue, Milwaukee 16, Wisconsin, U.S.A.—Illustrated brochure describing the "Sprawler" crane. Pivoting outriggers give the crane a lifting capacity of 30 tons.

BX PLASTICS, Ltd., Higham Station Avenue, Chingford, London, E.4.—Publication No. 605 describing "Bextrene" toughened polystyrene plastics materials developed for applications where extra toughness is required.

JOHN SUMMERS AND SONS, Ltd., Hawarden Bridge Steelworks, Shotton, Chester.—First edition of an illustrated quarterly review giving details of applications of steel sheet, particularly John Summers' plastic-coated steel, "Stelvetite."

JAMES GORDON AND CO., Ltd., Dalston Gardens, Stanmore, Middlesex.—Leaflet dealing with temperature measuring instruments suitable for power plant, industrial boilers, heating and ventilating installations and other industrial purposes.

SONDES PLACE RESEARCH LABORATORIES, Ltd., Dorking, Surrey.—Brochure giving details of the facilities offered for sponsored research and development in chemistry, chemical engineering, mechanical engineering and related subjects.

HOLOPHANE, Ltd., Elverton Street, London, S.W.1.—Industrial lighting catalogue, including details of a new range of translucent and covered fittings for heavy duty high bay applications, reflector-bowl cast pendants and weatherproof flameproof units.

BURNETT AND LEWIS, Ltd., Redhouse Industrial Estate, Aldridge, Walsall, Staffs.—Publication entitled *Wet Air—Dry Air* dealing mainly with standard fully automatic "Humidryers," used in the petroleum, chemical, nuclear engineering, power plant and general engineering industries.

INTERNATIONAL RECTIFIER COMPANY (GREAT BRITAIN), Ltd., Hurst Green, Oxted, Surrey.—Catalogue and price list containing details of power diodes from 250mA to 250A, 1W, 3·5W and 10W Zener diodes, controlled diodes, variable voltage capacitors, stack assemblies and high voltage up to 16kV.

NEGRETTI AND ZAMBRA, Ltd., 122, Regent Street, London, W.1.—Publications R30/2E dealing with electric switch and contact automatic controllers and alarm mechanisms; A/19 giving details of integrating indicator (type I.R.) for use with N. and Z. aircraft fuel flowmeter; F25/S, Spanish version of the company's general catalogue.

DOULTON INDUSTRIAL PORCELAINS, Ltd., Royal Doulton Potteries, Wilnecote, Tamworth, Staffs.—A pictorial review showing aspects of the production and testing of porcelain insulators at the Royal Doulton Works and High Voltage Laboratory. Publication No. 22 giving details of dimensions and characteristics of post insulators for very high voltages.

TURNERS ASBESTOS CEMENT COMPANY, Ltd., Trafford Park, Manchester, 17.—Four-page illustrated booklet describing "Siluminite" Electrofine asbestos paper and paper tape impregnated with silicone resin which is a class "C" electrical insulation paper for bonding to copper. Eight-page illustrated booklet covering natural grade "Sindanyo," an inorganic, non-combustible, fire- and flame-proof material for laboratory furniture.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Sat., May 14.—BIRMINGHAM BRANCH : Visit to Mitchell and Butlers, Ltd., Cape Hill Brewery, Smethwick, near Birmingham, 9.45 a.m.

Mon., May 16.—BRISTOL AND WEST OF ENGLAND BRANCH : The Grand Hotel, Bristol, "Waterworks Installations," 8 p.m.

Tues., May 17.—ALDERSHOT AND DISTRICTS BRANCH : Queens Hotel, South Farnborough, Hants, "High Voltage Porcelain Insulators," 7.45 p.m. ★ OXFORD AND DISTRICTS BRANCH : Employment Exchange, Oxford, Annual General Meeting, 7.30 p.m. ★ READING AND DISTRICTS BRANCH : Visit to Huntley and Palmers Biscuit Factory, Reading, 2.30 p.m.

Fri., May 20.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, Annual General Meeting, 7.30 p.m.

Fri. to Sun., May 20 *to* 22.—NATIONAL EVENT : Royal Hotel, Scarborough, Annual Conference.

BRITISH INSTITUTE OF MANAGEMENT

Wed., May 25.—Savoy Hotel, London, W.C.2, One-day conference on "Management Consultants in Industry and Commerce," 9.30 a.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Fri., May 20.—STUDENTS' MEETING : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Servomechanisms and Electronics Engineers—the Present and the Future," M. James, 7 p.m.

Wed., May 25.—Gustav Tuck Theatre, University College, London, Symposium on "Stable Frequency Generation"; "The Problem of Frequency Synthesis," H. J. Finden; "The Change-of-State Crystal Oven," D. J. Fewings; "The Application of Counting Techniques to the Control of High Stability H.F. Oscillators," R. P. Thatte; "A Transistorised Frequency Synthesizer" G. Husson and B. N. Sherman; "The Synthesis of High Purity Oscillations Suitable for Single Sideband Receivers," P. S. Carnt and E. Ribchester, and "An Airborne Frequency Generating Unit for the H.F. Communication Band," G. E. Smythe, 3 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs., May 19.—MIDLAND REGION : Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, Discussion on "The Automatic Boiler House," opened by M. A. Beechly, 10.15 a.m.

Tues., May 24.—SCOTTISH REGION : Royal Hotel, 5, Union Street, Dundee, Discussion on "Clean Air and Industry," 10.30 a.m., and a Discussion on "Water Treatment for Industrial Boiler Plant," opened by D. S. Kerr, 2 p.m. ★ Engineers' Club, Albert Square, Manchester, Open Discussion on "Combustion Problems," opened by the Right Worshipful the Lord Mayor of Manchester, Alderman Harold Quinney, 10.30 a.m. and 2.30 p.m.

ENGINEERING INDUSTRIES ASSOCIATION

To-day and Sat., May 13 *and* 14.—2ND NATIONAL CONFERENCE : Royal Hotel, Scarborough, "The Development of Your Business," 9.30 a.m.

ILLUMINATING ENGINEERING SOCIETY

Sun. to Wed., May 15 *to* 18.—SUMMER MEETING : Royal Hall, Harrogate.—*Mon., May* 16 : "Progress in the Field of Electric Lamps," H. G. Jenkins, 10 a.m.; "Rationally Recommended Illumination Levels," H. C. Weston, 2.30 p.m.; *Wed., May* 18 : "Plastics, Yesterday, To-day and To-morrow," C. L. Child, 10 a.m.

INSTITUTE OF FUEL

Mon., May 23.—Institution of Civil Engineers, Great George Street, London, S.W.1, "Recommendations on Heights for New Industrial Chimneys," G. Nonhebel, 5.30 p.m.

INSTITUTE OF PETROLEUM

Wed. to Sun., May 25 *to* 29.—Summer Meeting at Bournemouth, Theme, "Planning for Productivity in the Petroleum Industry."

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, May 13.—SOUTH WALES CENTRE : South Wales Institute of Engineers, Park Place, Cardiff, Films, "Cummins Diesels," 7.15 p.m.

Wed., May 18.—EAST MIDLANDS CENTRE : Visit to Pirelli, Ltd., Derby Road, Burton-on-Trent, 2 p.m.

Tues., May 31.—METROPOLITAN AREA : Visit to the brewery of Watney Combe Reid and Co., Ltd., 10 a.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., May 17.—Great George Street, Westminster, London, S.W.1, "Port of London Authority—Development of Two Dock Areas, 1959," D. E. Glover, E. Newton, H. M. Dale, and T. R. Brown, 5.30 p.m.

Tues., May 24.—Great George Street, Westminster, London, S.W.1, "The New Highway Bridges Across the River Tigris in Iraq at Amara and Kut," W. E. Gelson and G. A. Plank, and "The Analysis of Steel Decks with Special Reference to the Highway Bridges at Amara and Kut, Iraq," B. Farago and W. W. L. Chan, 5.30 p.m.

Thurs., May 26.—Great George Street, Westminster, London, S.W.1, Films, "London to Birmingham Motorway" and "The Changing Face of Lincoln," 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., May 16.—NORTH STAFFORDSHIRE SUB-CENTRE : Technical College, Stafford, Annual General Meeting, and "The Characteristics and Protection of Semiconductor Rectifiers," D. B. Corbyn and N. L. Potter, 7 p.m. ★ LONDON GRADUATE AND STUDENT SECTION : Savoy Place, London, W.C.2, Annual General Meeting, and Films, 6.30 p.m.

Wed., May 18.—SHEFFIELD SUB-CENTRE : Grand Hotel, Sheffield, Annual General Meeting, and "The Design of Housing-Estate Distribution Systems Using a Digital Computer," R. L. Grimsdale and P. H. Sinclare, 6.30 p.m.

Thurs., May 19.—LONDON SECTION : Savoy Place, London, W.C.2, Annual General Meeting, and "Technical Features of a New Television Studio at Wembley," A. M. Spooner, 5.30 p.m.

Fri. to Mon., May 20 *to* 23.—WESTERN CENTRE : Abernant Lake Hotel, Llanwrtyd Wells, Summer Meeting.

Wed., May 25.—ELECTRONICS AND COMMUNICATIONS SECTION : Savoy Place, London, W.C.2, Discussion on "New Semiconductor Devices and Their Possible Applications," opened by A. F. Gibson and G. King, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., May 18.—YORKSHIRE BRANCH : Midland Hotel, Bradford, "Plastics," 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Fri., May 27.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Joint Meeting with the Aluminium Development Association, Symposium on "The Use of Aluminium in Railway Rolling Stock," 10 a.m. and 2.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon., May 16.—MIDLAND GRADUATES' SECTION : Engineering Centre, Stephenson Place, Birmingham, Visit of Mr. K. H. Platt : Talk and Discussion, 7 p.m.

Wed., May 18.—AUTOMOBILE DIVISION : 1, Birdcage Walk, Westminster, London, S.W.1, "Automotive Development Trends in the U.S.A.," A. A. Kucher, 6 p.m.

Thurs., May 19.—SOUTHERN BRANCH : Visit to the factories of Welworthy, Ltd., in the Lymington and Ringwood areas, 4 p.m.

Fri. to Sun., May 20 *to* 22.—EASTERN GRADUATES' SECTION : Annual works visit to SIMCA Factory at Poissy and Institut Français de Pétrole at Reuil-Malmaison, near Paris.

Tues., May 24.—LONDON GRADUATES' SECTION : 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting; Election of the Committee for the 1960-61 Session, and "The Mechanical Aspects of Fractional Horsepower Motors," P. G. Edkins, 6.30 p.m. ★ MIDLAND GRADUATES' SECTION : Evening Visit to Stewarts and Lloyds, Ltd., Erdington, Birmingham.

Wed., May 25.—1, Birdcage Walk, Westminster, London, S.W.1, Special Meeting, 6 p.m. ★ EAST MIDLANDS GRADUATES' SECTION : Whole-day visit to Stewarts and Lloyds, Ltd., Corby Works.

Thurs., May 26.—SCOTTISH BRANCH : Evening visit to L. Sterne and Co., Ltd., Kelvin Avenue, Hillington.

Fri., May 27.—SCOTTISH GRADUATES' SECTION : Joint visit with the Northern Ireland Graduates' Section to the steel works of Colvilles, Ltd., 9.45 a.m.

Sat., May 28.—SOUTHERN BRANCH : Visit to the Havant Pumping Station, 2.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., May 19.—Geological Society, Burlington House, Piccadilly, London, W.1, Annual General Meeting, 4 p.m.

INSTITUTION OF PLANT ENGINEERS

Sat., May 14.—WESTERN BRANCH : Visit to British Railways Swindon Works, 10.30 a.m.

Wed., May 18.—KENT BRANCH : Kings Head Hotel, High Street, Rochester "Use of Liquid Petroleum Gas" A. G. Turner, 7 p.m. ★ LONDON BRANCH : Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "Factory Safety," 7 p.m.

Thurs., May 19.—BLACKBURN BRANCH : Castle Hotel, Blackburn, "Some Medium-Sized Boiler Houses," G. A. Rooley, 7.30 p.m.

Tues., May 24.—S. WALES BRANCH : South Wales Institute of Engineers, Park Place, Cardiff, "Controlled Maintenance," G. E. Halter, 7.30 p.m.

Thurs., May 26.—MERSEYSIDE AND NORTH WALES BRANCH : Exchange Hotel, Liverpool, "Packaging and Container Engineering," E. Evans, 7.15 p.m.

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS

Mon. to Wed., May 23 *to* 25.—Winter Garden, Eastbourne, Sussex, Annual Delegate Conference.

PLASTICS INSTITUTE

Fri. to Sun., May 20 *to* 22.—Institute Visit to the Midlands Section.

ROYAL AERONAUTICAL SOCIETY

Tues., May 17.—HISTORICAL GROUP : Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, "My First Ten Years," Sir Thomas Sopwith, 6 p.m.

Thurs., May 19.—48TH WILBUR WRIGHT MEMORIAL LECTURE : Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, "Mathematics and Aeronautics," M. J. Lighthill, 6 p.m.

ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY

Tues. to Fri., May 17 *to* 20.—Department of Mechanical, Civil and Chemical Engineering, Glasgow, C.1, Symposium on "Nuclear Reactor Containment Buildings and Pressure Vessels."

ROYAL INSTITUTION OF GREAT BRITAIN

Wed., May 25.—21, Albemarle Street, London, W.1, "Luminescence—The Cold Light of Physics," G. F. J. Garlick, 9 p.m.

ROYAL INSTITUTION OF NAVAL ARCHITECTS

Mon. to Fri., May 16 *to* 20.—Royal Festival Hall, London S.E.1, Centenary Meeting.

ROYAL METEOROLOGICAL SOCIETY

Wed., May 18.—49, Cromwell Road, London, S.W.7, "The Summer Circulation of the Arctic Stratosphere below 30km," F. K. Hare; "An Experimental System for Directly Recording Statistics of the Intensity of Atmospheric Turbulence," J. I. P. Jones and F. Pasquill, and "The Reflection of Short-Wave Radiation by Vegetation," J. L. Monteith, 5 p.m.

ROYAL SOCIETY OF ARTS

Mon., May 16.—CANTOR LECTURE : John Adam Street, Adelphi, London, W.C.2, "Energy—The Transmission of Power," F. H. S. Brown, 6 p.m.

Mon., May 23.—CANTOR LECTURE : John Adam Street, Adelphi, London, W.C.2, "Energy—The Retail Distribution of Electricity," C. Robertson King, 6 p.m.

Wed., May 25.—John Adam Street, Adelphi, London, W.C.2, "Problems and Prospects of Air Transport," P. G. Masefield, 2.30 p.m.

ROYAL STATISTICAL SOCIETY

Wed., May 25.—7TH ORDINARY MEETING : London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, "Decision Making in the Steel Industry," K. D Tocher and A. Muir, 5.15 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., May 24.—Manson House, 26, Portland Place, London, W.1, Annual General Meeting, 6 p.m., Presidential Address. R. S. Medlock, 7 p.m.

SOUTH WALES INSTITUTE OF ENGINEERS

Thurs., May 19.—Institute Buildings, Park Place, Cardiff, "The Aberthaw Power Station," W. Wilde, 6 p.m.

TELEVISION SOCIETY

To-day, May 13.—The Cinematograph Exhibitors' Association Theatre, 3rd Floor, 164, Shaftesbury Avenue, London, W.C.2, "The Status of Storage Tubes in America," R. R. Law, 7 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, May 13.—39, Elmbank Crescent, Glasgow, C.2, All-day conference on "Internal Defects in Steel and Methods of their Assessment," 10 a.m.

WOMEN'S ENGINEERING SOCIETY

Wed., May 18.—LONDON BRANCH : "Hope House," 45, Great Peter Street, Westminster, London, S.W.1, "Electronic Weighing," Miss R. Winslade, 7 p.m.

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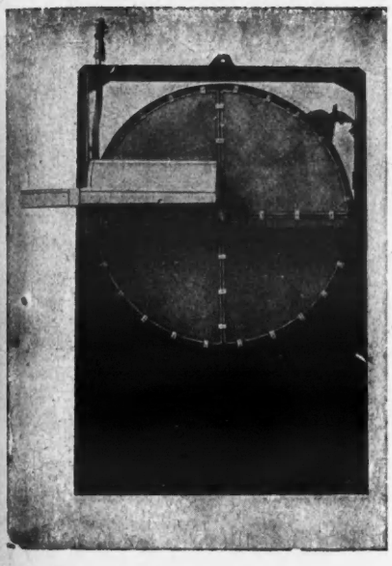

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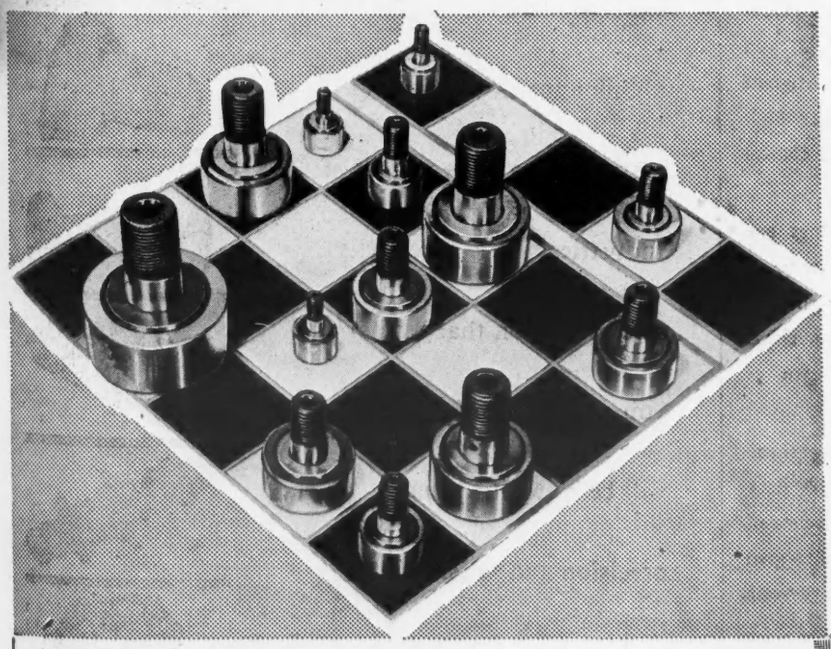

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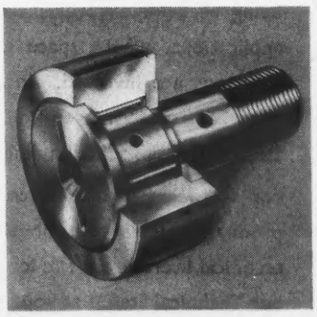

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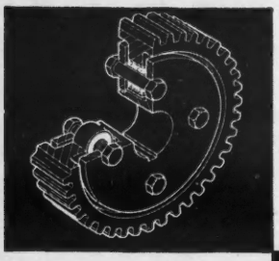

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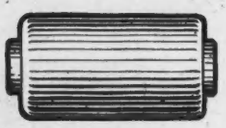

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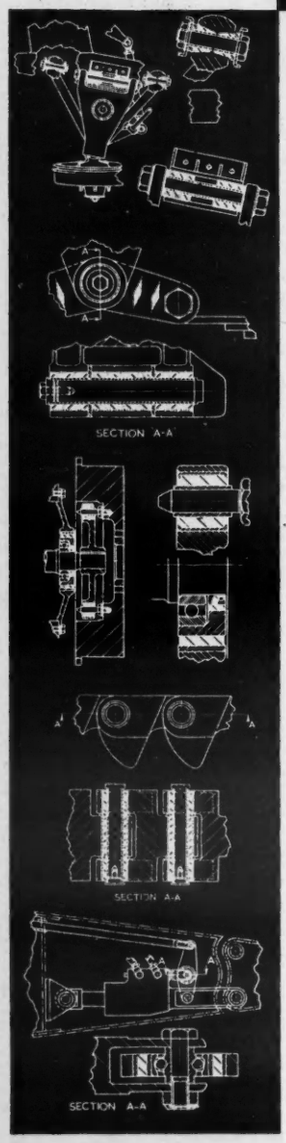

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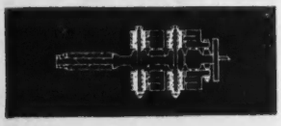

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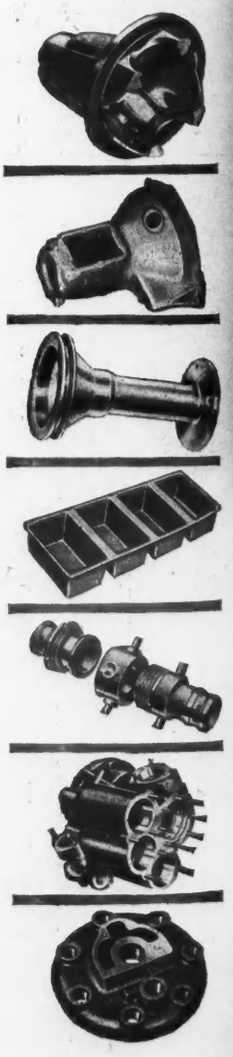

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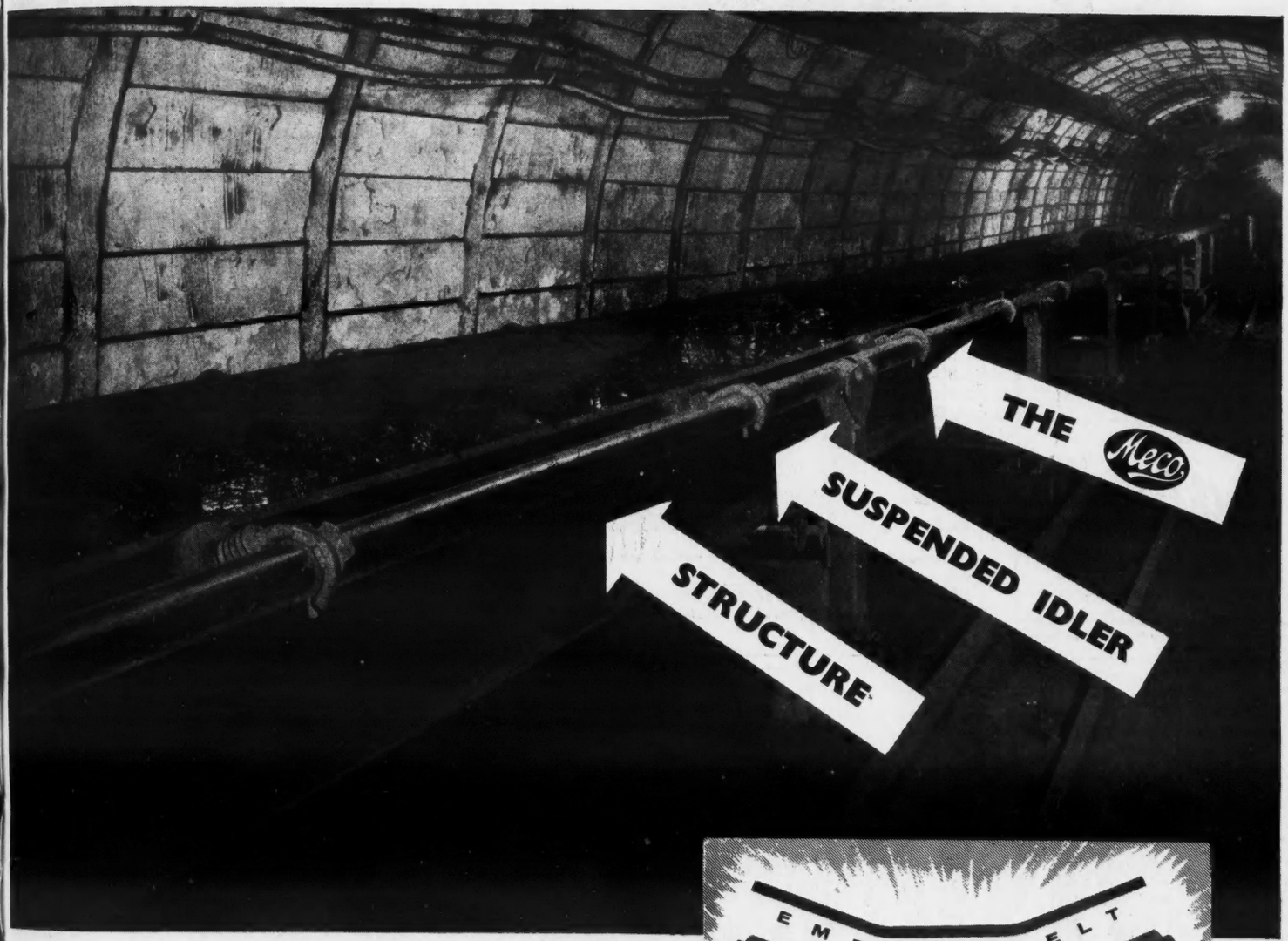

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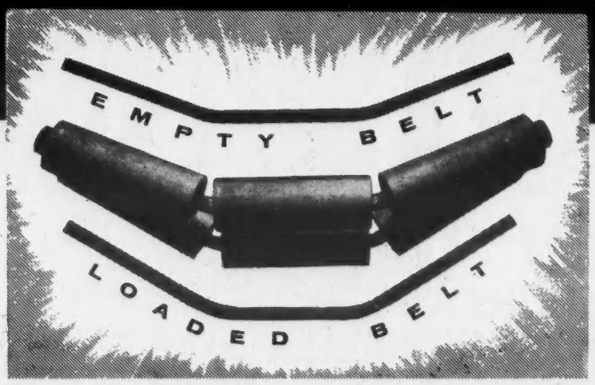

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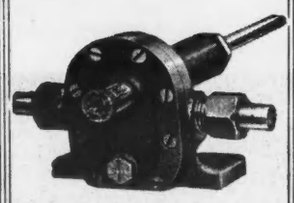

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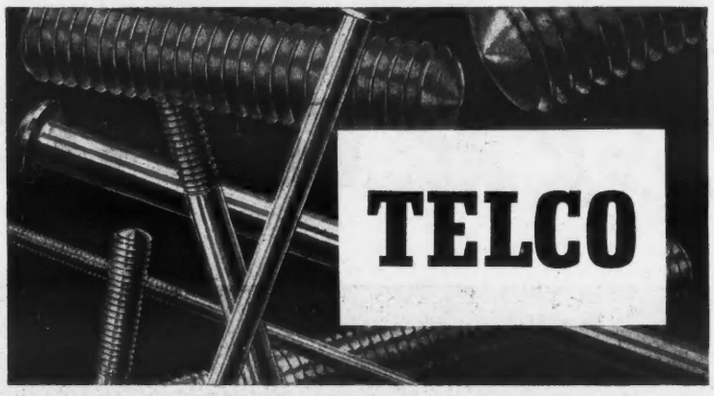

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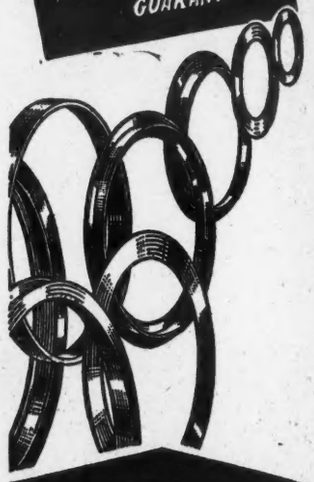

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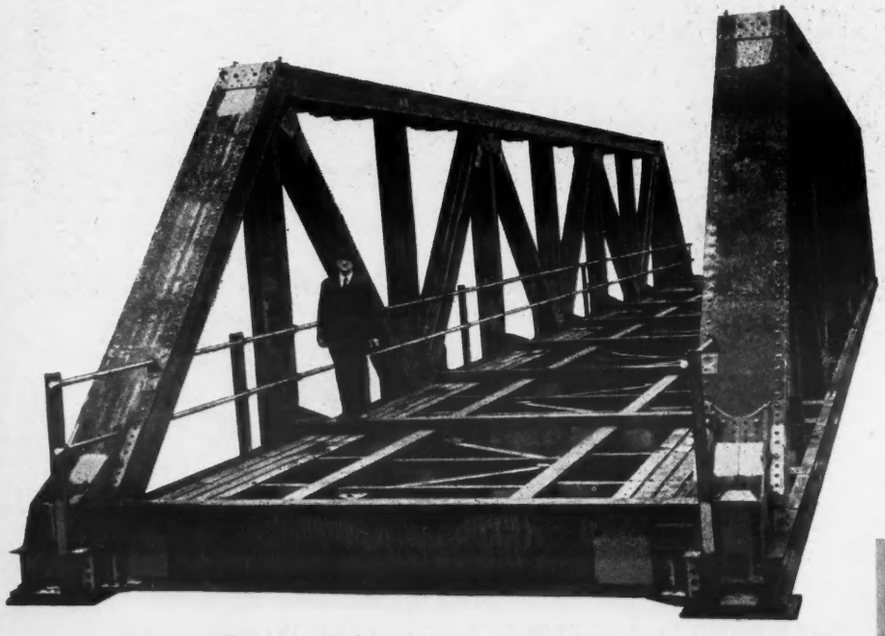

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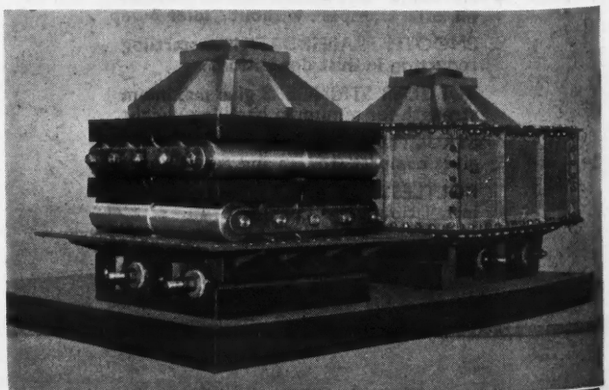

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Electrical Aids in Industry *Data Sheet* **No. 11**

Dielectric Heating - 2

The ability of dielectric heating to generate heat through the mass of a suitable material provides the following considerable advantages over other heating methods.

1 A body of uniform section and composition is raised in temperature uniformly throughout. Hence there is no waiting for heat to be transferred from an external heat source to the surface of the body and thence to its interior, and this is of particular advantage when the body is thick, and, as is often the case with dielectric materials, has poor heat-conducting properties.

2 The rate of heating of such bodies is, therefore, much faster than by external heating methods.

3 Since there is no external heat source, overheating or burning of the surface of a heat-sensitive material is avoided.

4 High thermal efficiency is achieved.

5 The amount of heat generated in the work is usually predictable and power input and heating time can be under positive control.

6 Production can start immediately after switching on, and no current is used, nor heat lost, during periods of shut-down.

7 Vastly increased productivity is obtainable with less labour (usually unskilled), and fewer machines and less floor space are required.

8 Flexibility of layout makes it possible to plan the factory to best advantage, as dielectric heating equipment can usually be inserted directly into the production line.

Dielectric Heating: typical application data

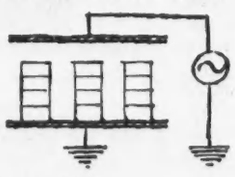
Typical application	Frequency	Radio frequency power
Thermoplastic welding.	20-100 Mc.p.s.	Up to 1 kW
Plastic preheating, wood glueing.	10-40 Mc.p.s.	2-30 kW
Plywood manufacture.	2-10 Mc.p.s.	Above 30 kW

Note: 1 Mc.p.s. = 1,000,000 cycles per second.

A few of the industrial applications of dielectric heating are briefly described below.

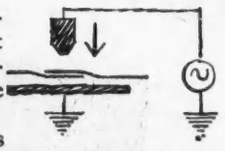
Preheating Thermosetting Plastics

Dielectric heating is the ideal way of preheating moulding powder pellets used in the production of thermosetting plastic mouldings, since these materials are generally poor heat conductors. Properly applied, dielectric preheating promotes faster curing and hence a shorter moulding time, often increasing production ten to fifteen times. There is a marked reduction in tool wear, and thicker sections can be moulded, as the material is plastic when placed in the mould. There is less damage to, and movement of, metal inserts.



Welding of Thermoplastic Materials

An important and extensive application of dielectric heating in the plastic industry is the welding of thermoplastic sheets in the fabrication of such commonly used articles as raincoats, hoods, handbags, pouches and packaging materials. Dielectric heating is the only method which can usefully be employed, since the heating electrodes, and hence the outside sheet surfaces, remain cool while the inside surfaces forming the joint are fused, and a perfect weld results.



Two or more thermoplastic sheets are welded under pressure from electrodes suitably shaped to the area of weld required, the current being switched on at the same time as pressure is applied, and off as soon as the weld is completed and the pressure released. Stitching is thus eliminated and a far stronger joint achieved.

In most cases, component pieces are first cut from patterns and preliminary welding carried out to attach any fastening tabs and the like. The pieces are then brought together in a suitable loading frame and the main welding carried out to produce the complete article. In some cases, a suitably profiled electrode can be fitted with a knife edge to cut the sheets immediately outside the weld line, welding and pattern-cutting being thereby carried out in the one operation. Dielectric welding can be applied also to very large thermoplastic products such as linings for swimming pools, and cinema screens.

Drying

Drying of materials by dielectric heating has the great advantage that the material tends to dry out from the centre, the reverse of what happens when external heating methods are employed, and the risk of overdrying and overheating of the surface is eliminated. In general ½ to 1 unit of electricity is required to drive off 1 lb. of moisture, depending upon the thermal properties of the material being dried. While the removal of large amounts of water from inexpensive commodities may sometimes be uneconomical, dielectric heating in the production line often leads to a higher overall production efficiency. It is valuable for removing final moisture traces and becomes increasingly economical as the value or heat-sensitivity of the commodity increases.

Rubber

External heating tends to dry and cure the surfaces of a thick latex mass before its centre, but dielectric heating properly applied promotes uniform conditions throughout.

Loaded rubber may not heat uniformly in a dielectric field due to uneven dispersion of its load, but nevertheless rubber preforms loaded up to about 15% are preheated dielectrically to reduce moulding times appreciably, the temperature evening out in the mould to give uniform curing.

Further examples are given in Data Sheet No. 12.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone : TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available — "Induction and Dielectric Heating" is an example.

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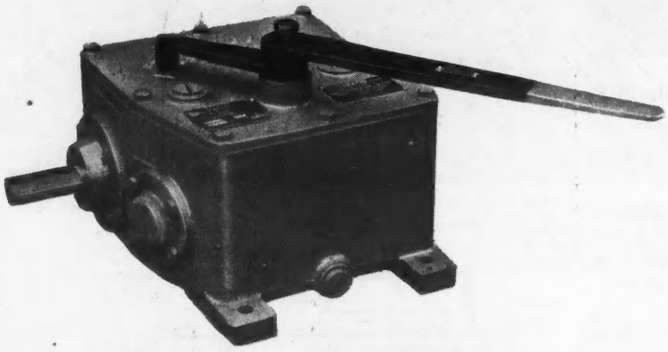

- **without the use of a clutch**
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The "Varatio" Positive Variable Change Speed Gear Box has the outstanding merit of ROBUST SIMPLICITY COUPLED WITH HIGH EFFICIENCY AND COMPLETE RELIABILITY, and is eminently suitable for every industrial requirement where variability of speed and a positive drive at pre-determined SPEEDS MAINTAINED WITHOUT SLIP are required.

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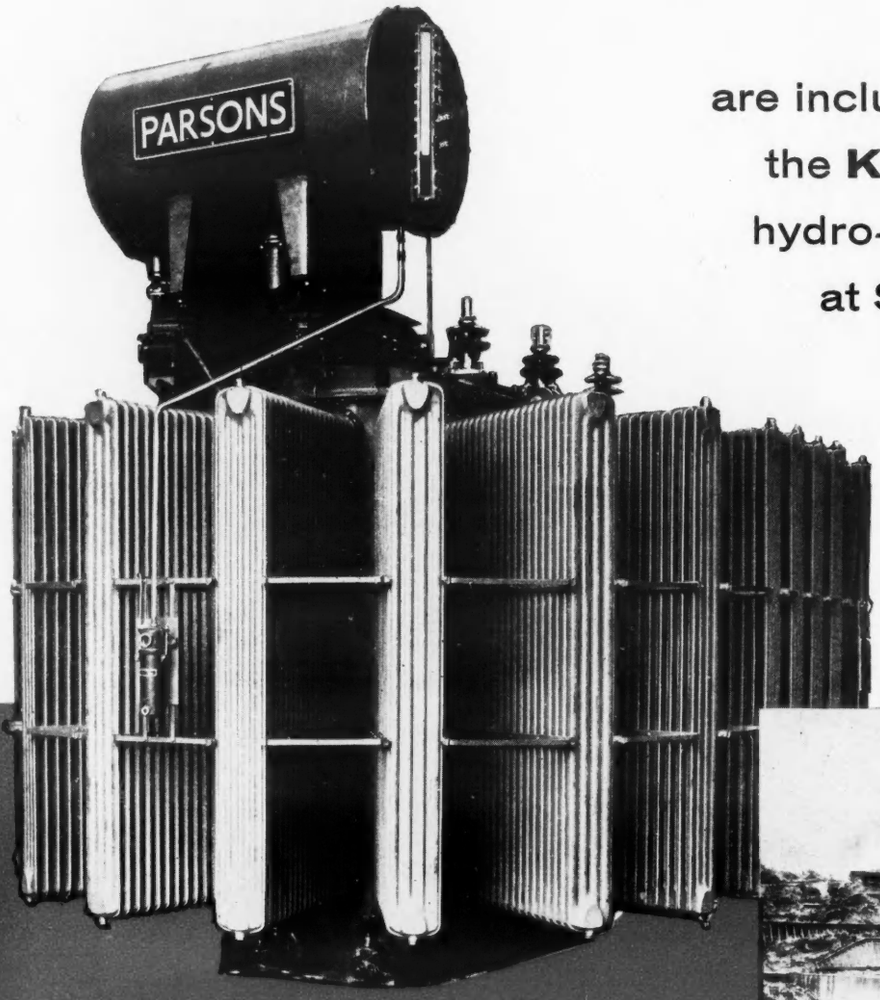

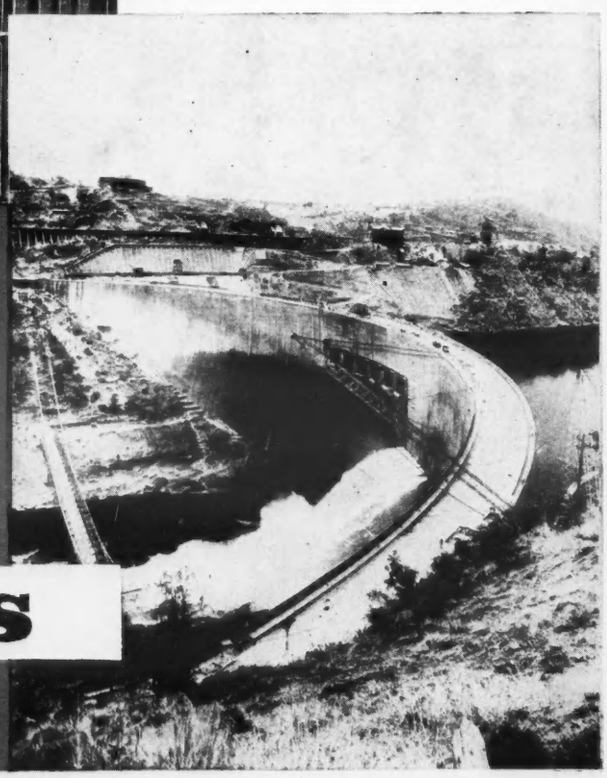

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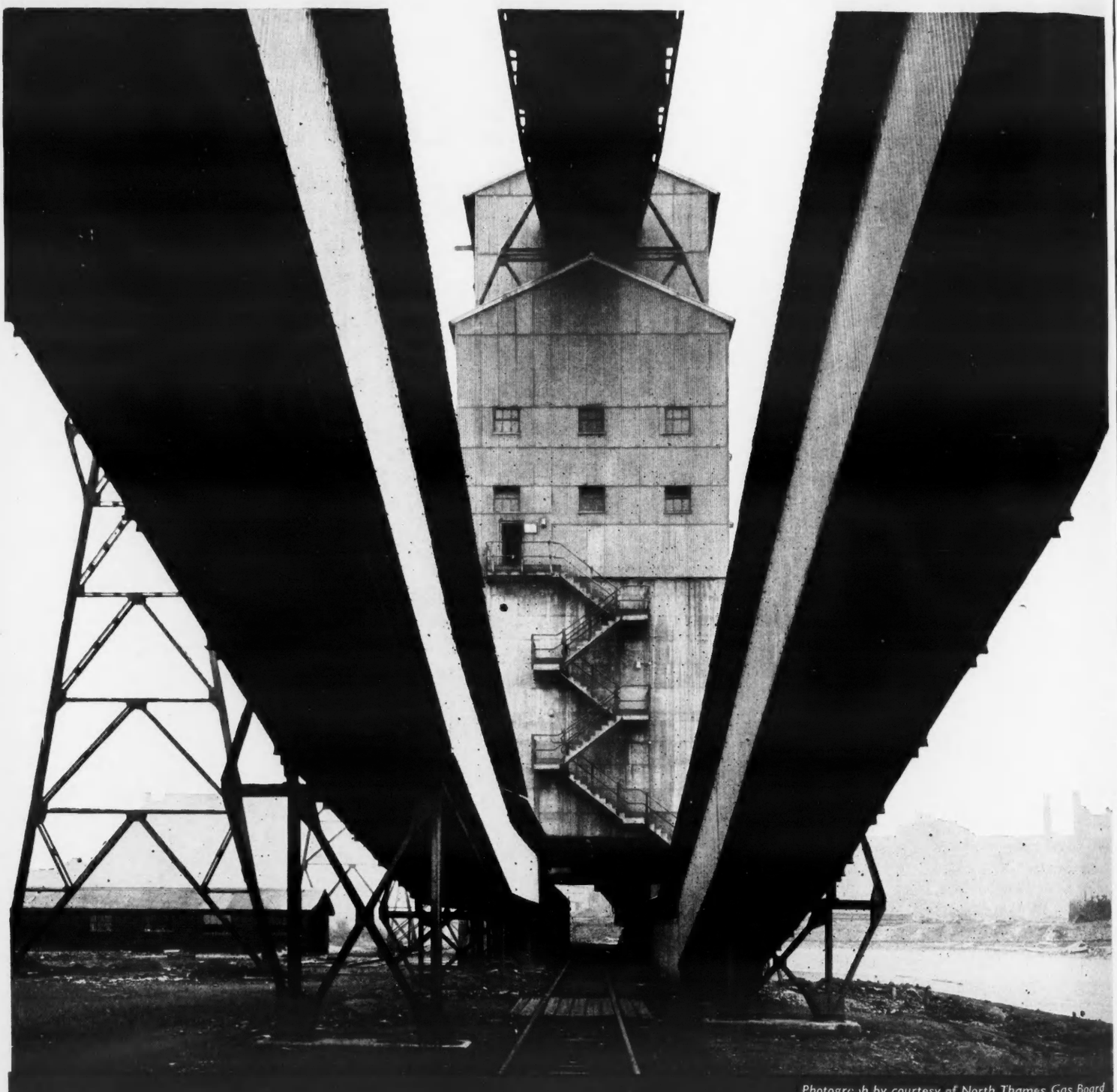

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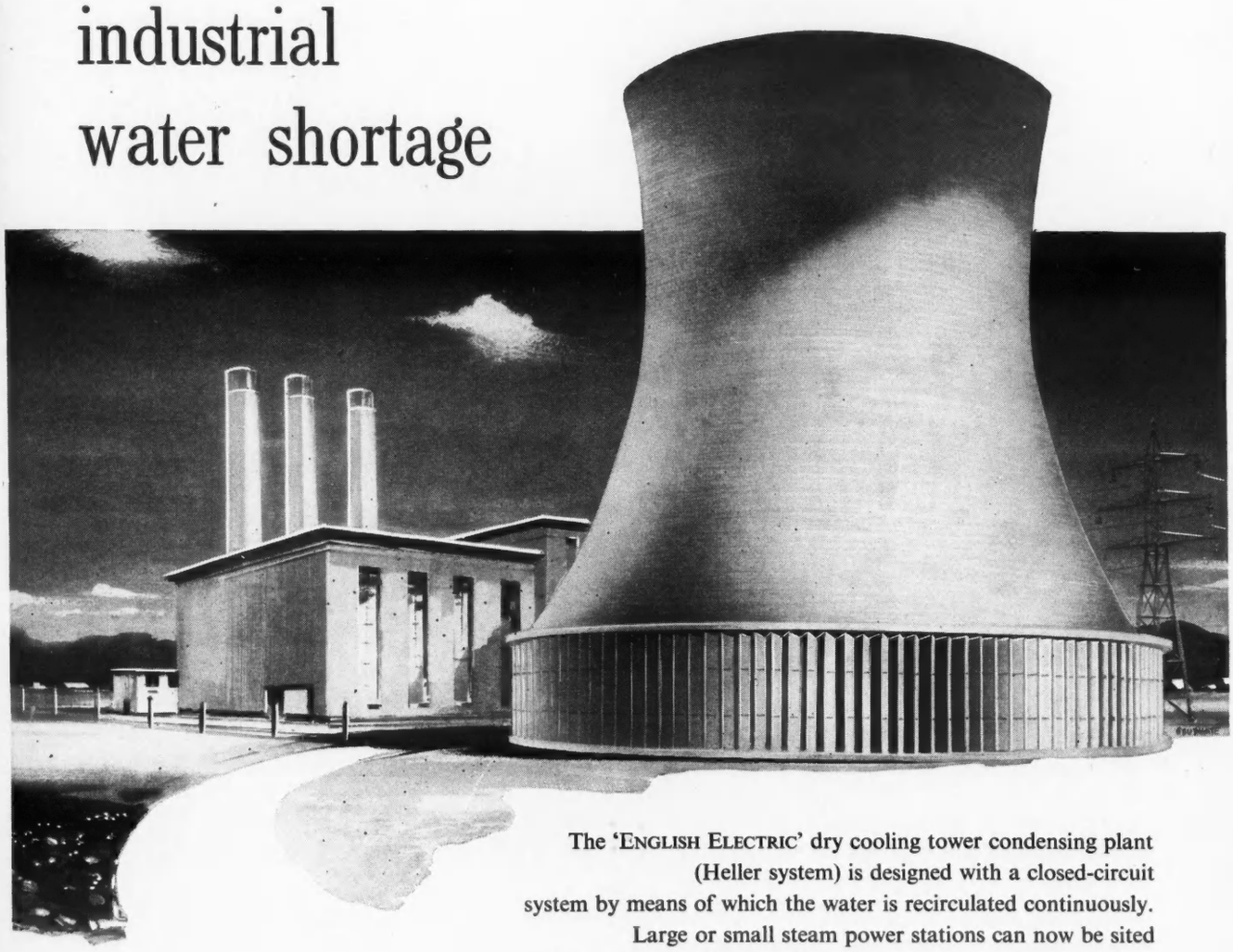

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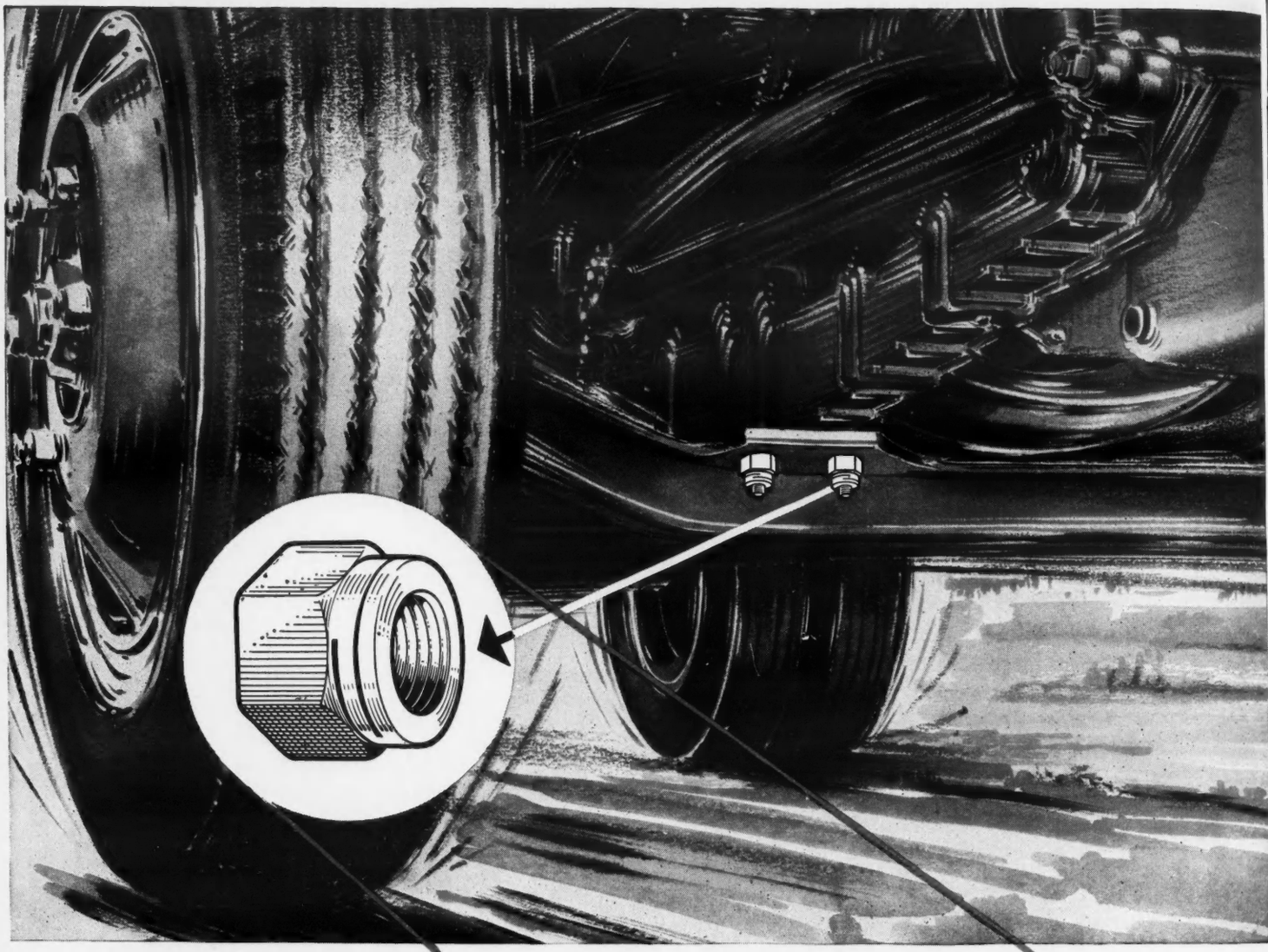

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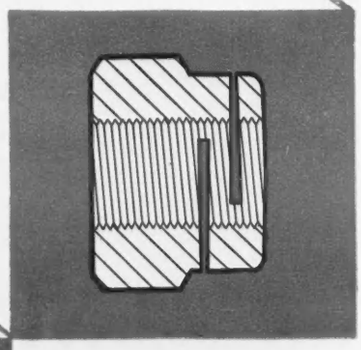

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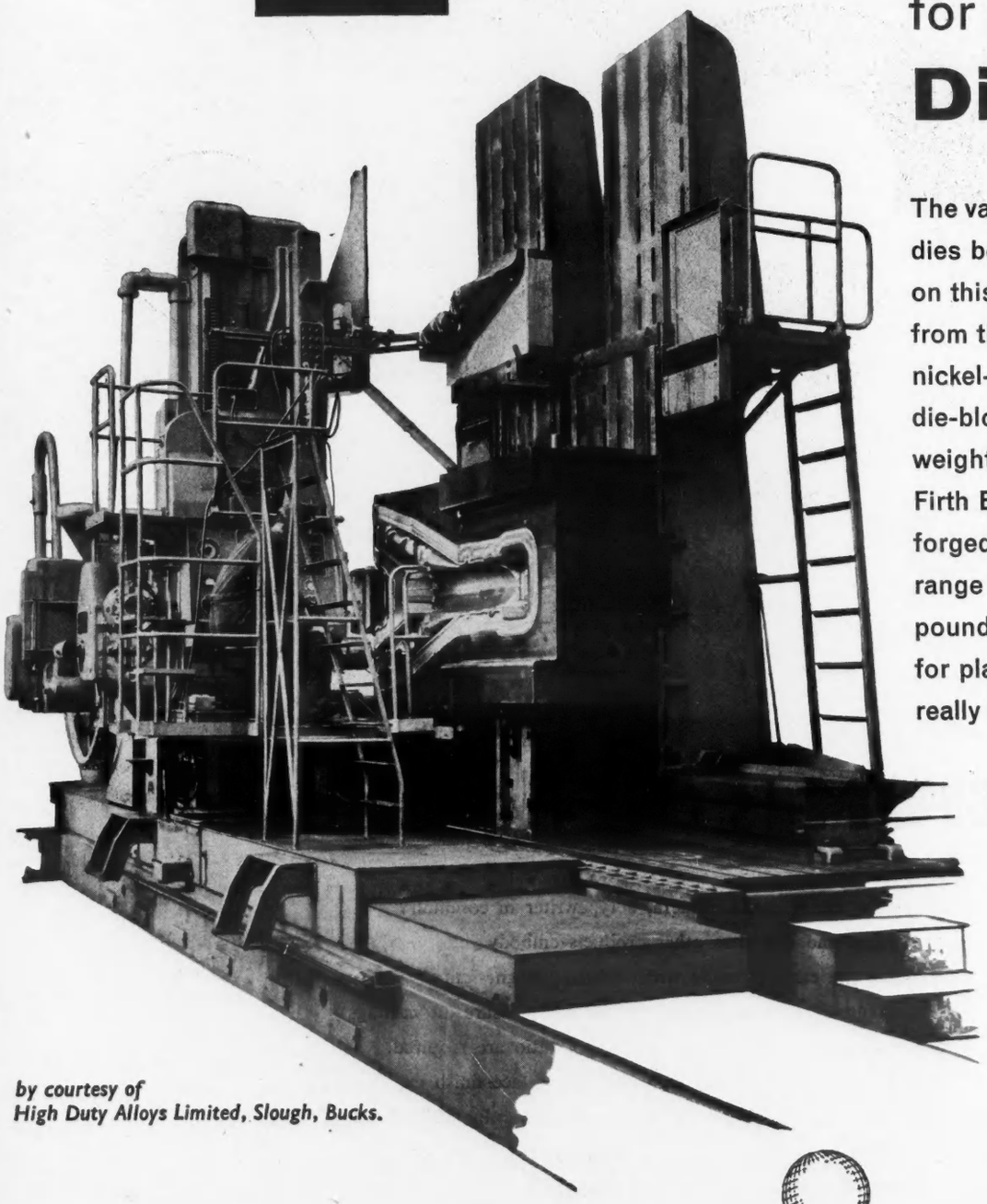

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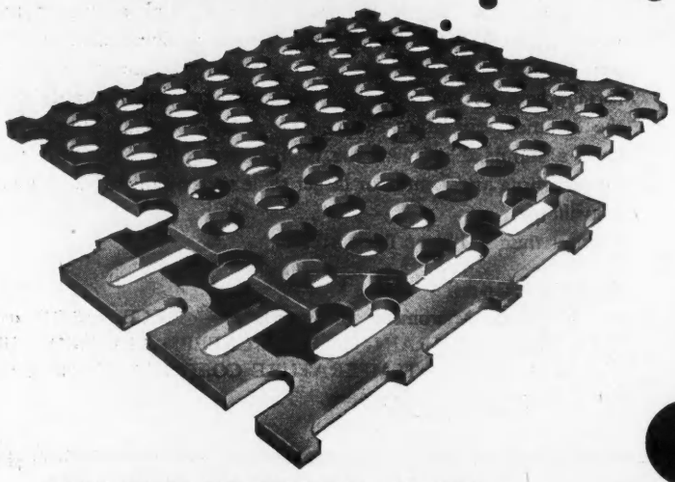

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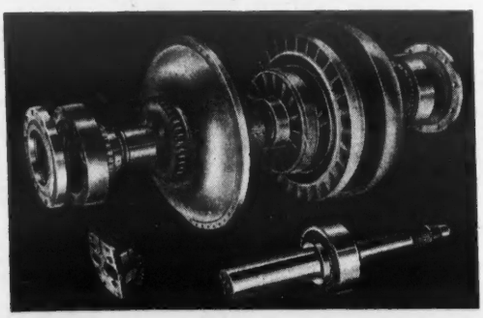

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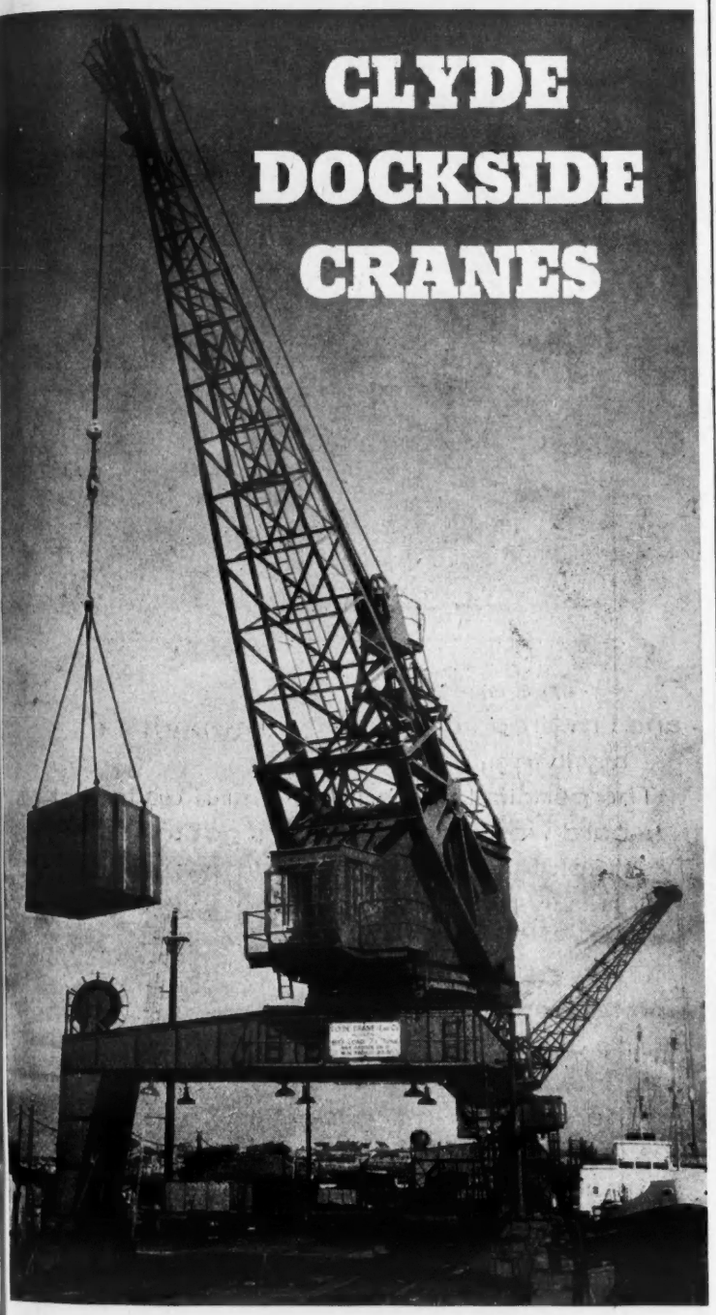

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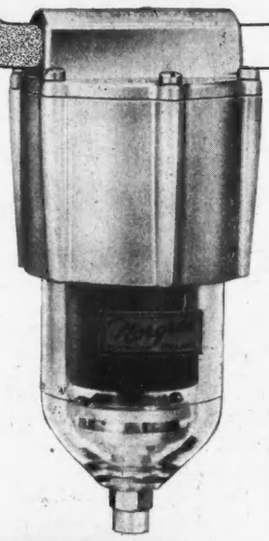

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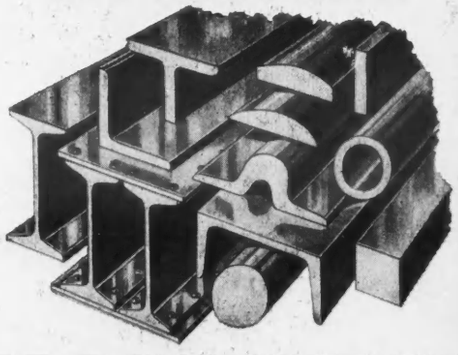

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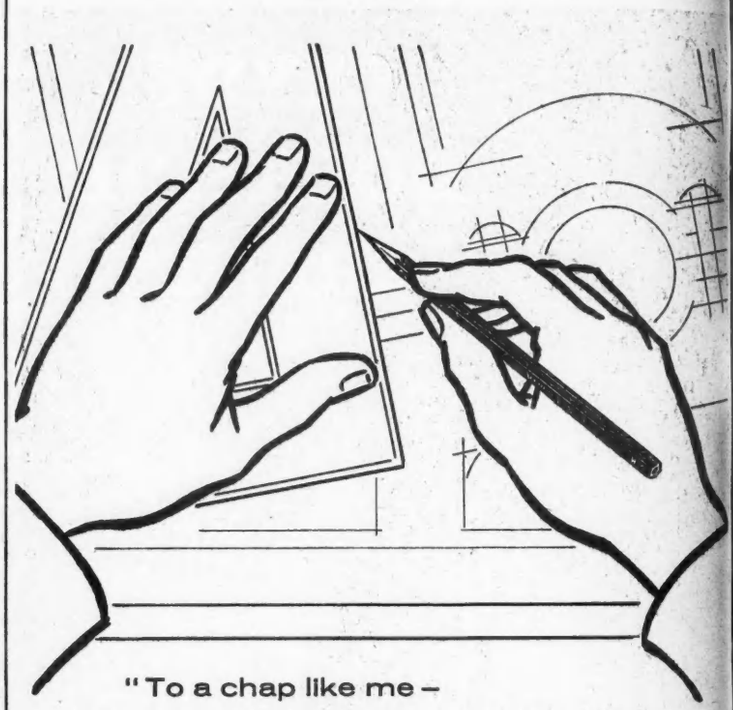

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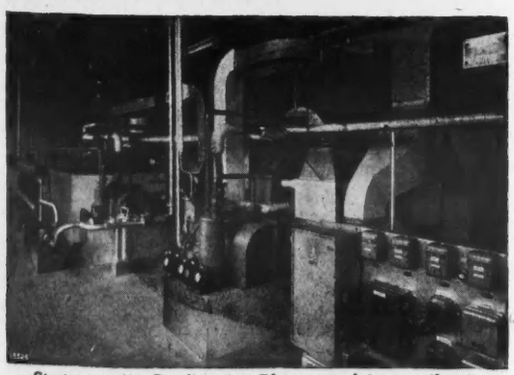
A Gauge, Standards and Checking Room of an engineering works, air conditioned by Sturtevant Plant: note diffusers.

The Quantometer Room at Stewarts and Lloyds Ltd., Corby, served by Sturtevant Air Conditioning Plant.



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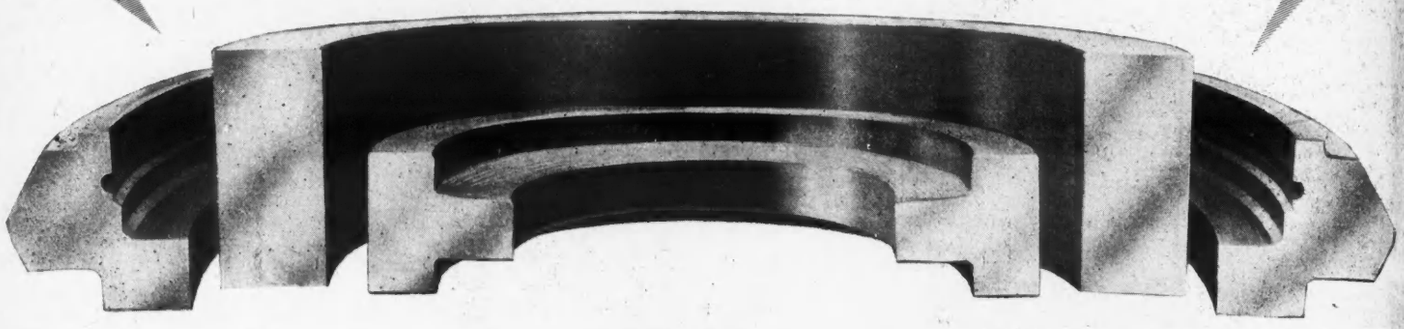

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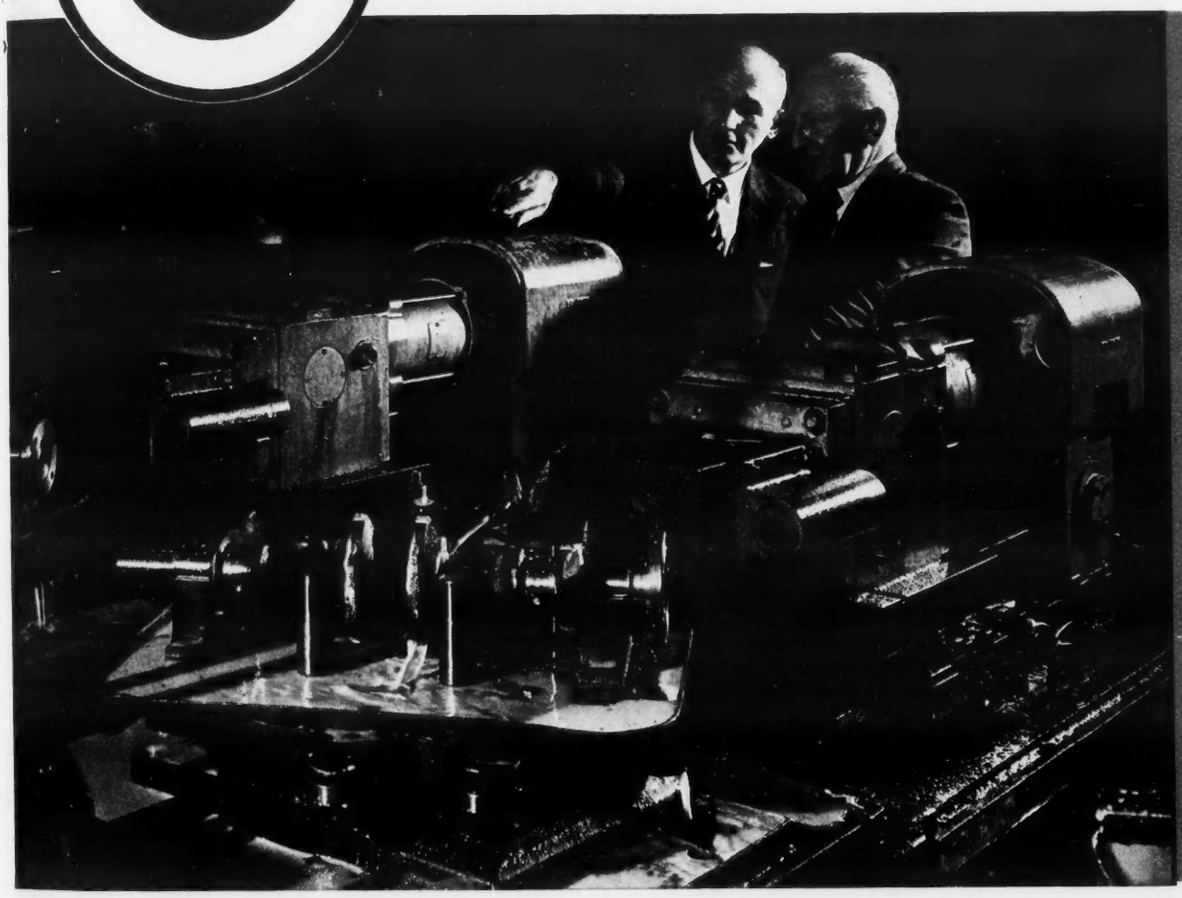

Mr. W. H. Homan-Berry, Austin's Assistant chief planning engineer says:

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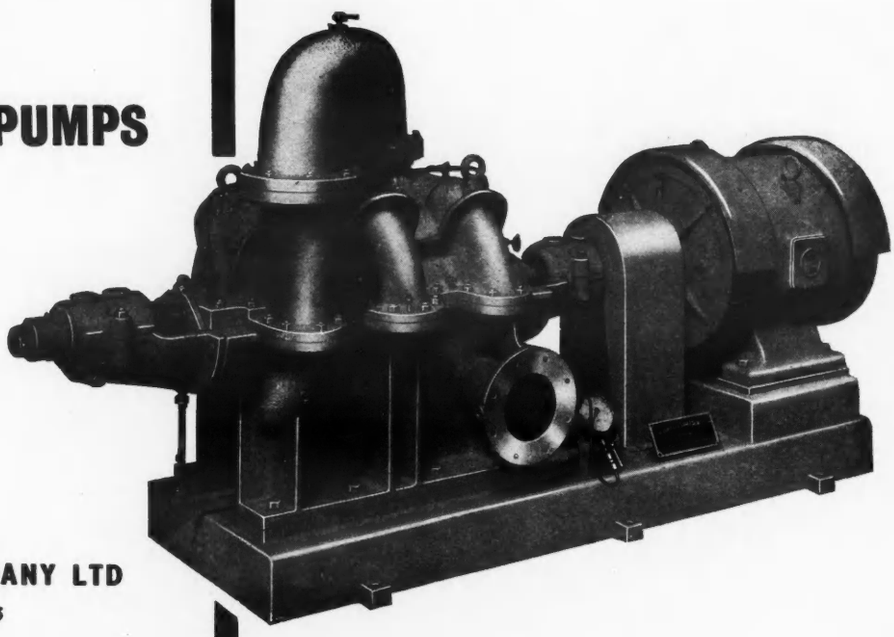

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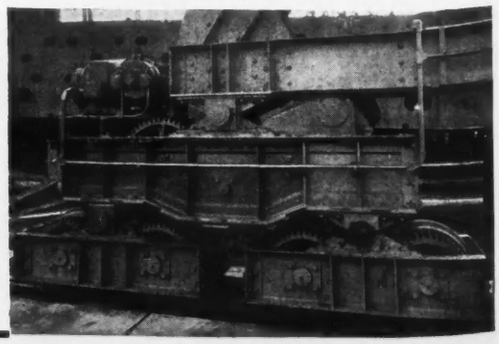

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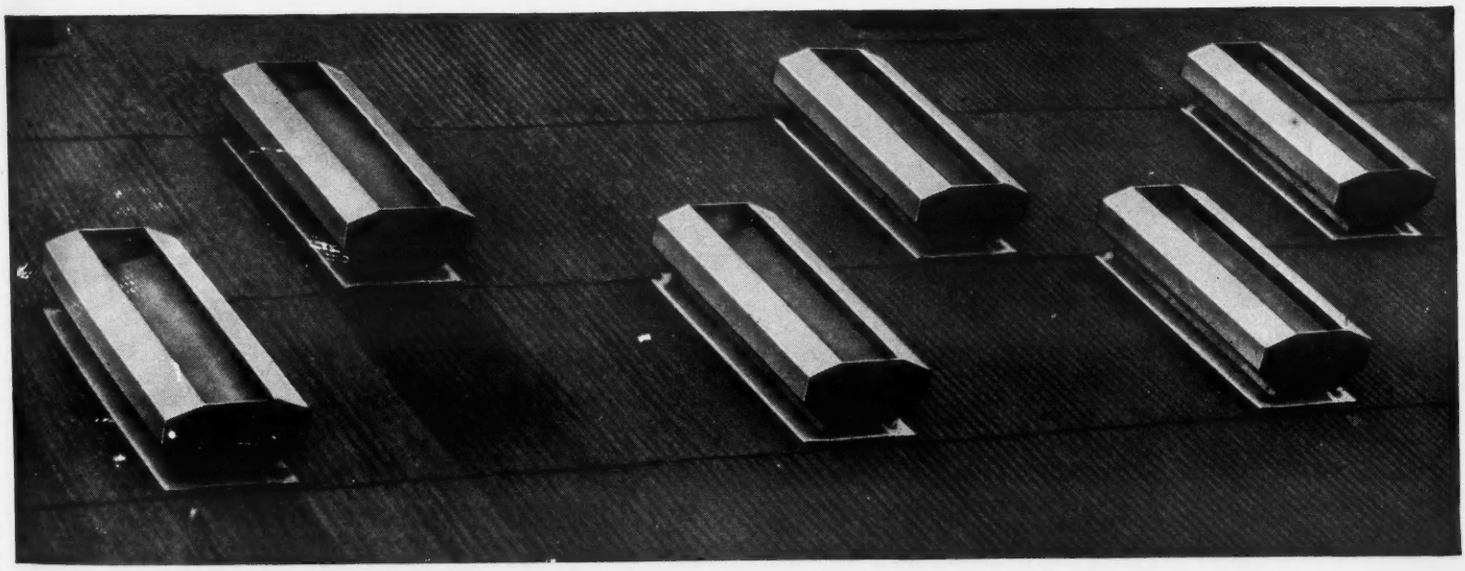

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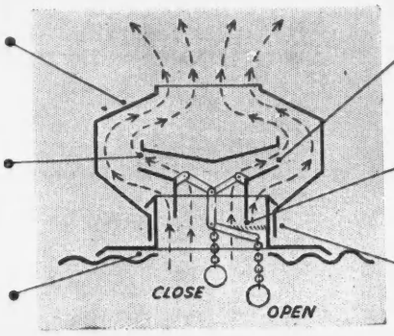

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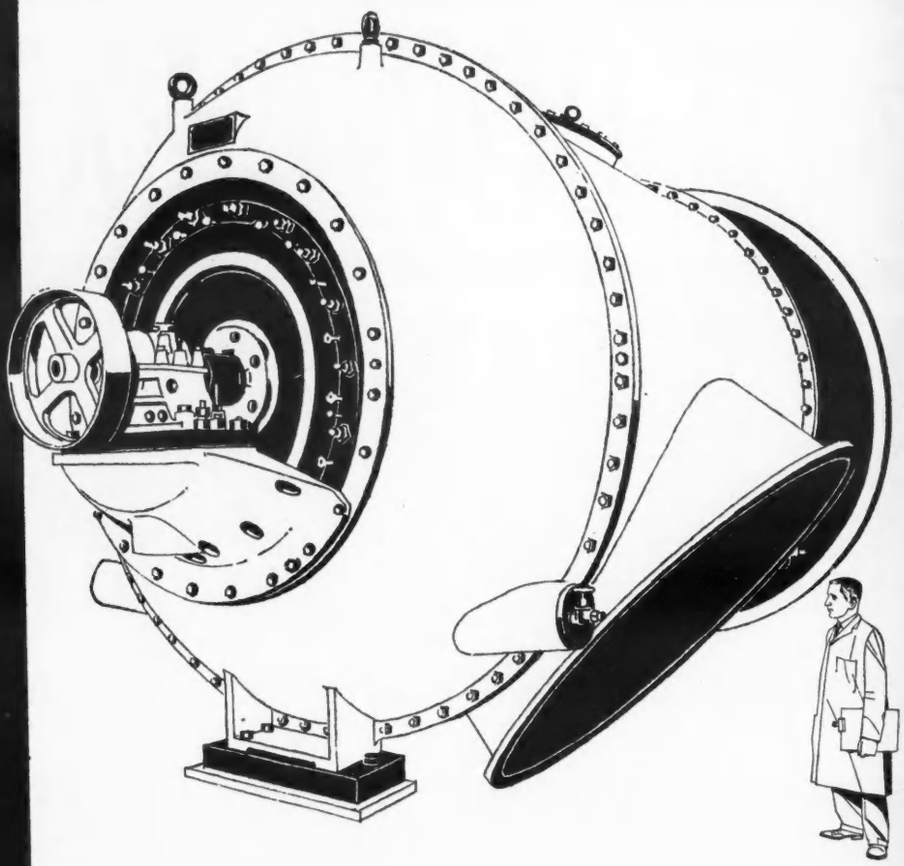

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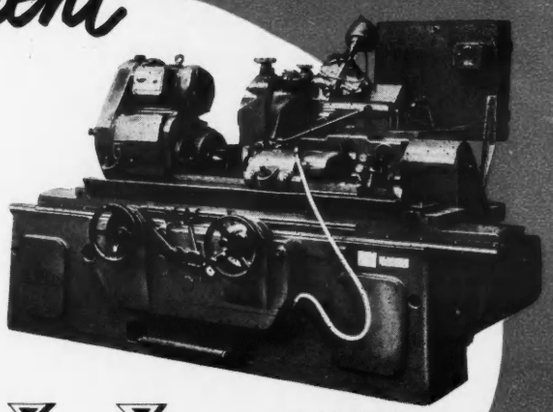

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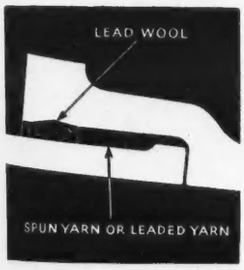

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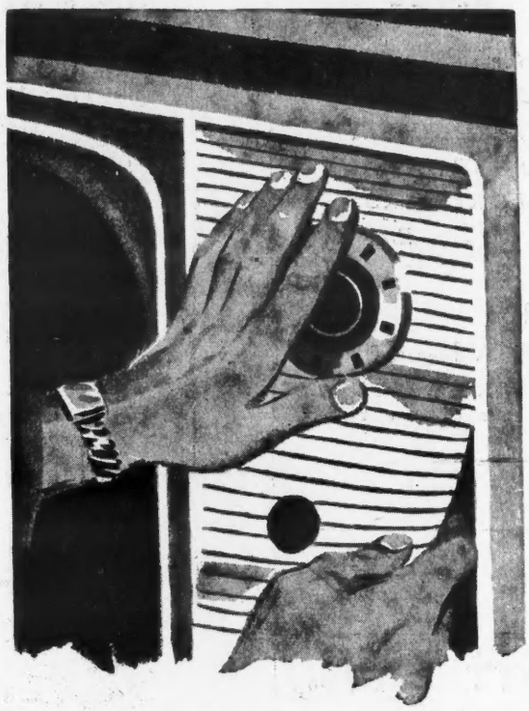

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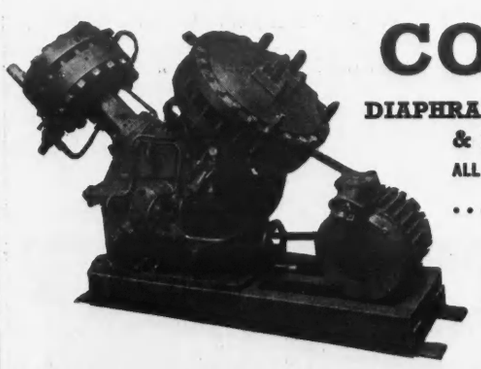

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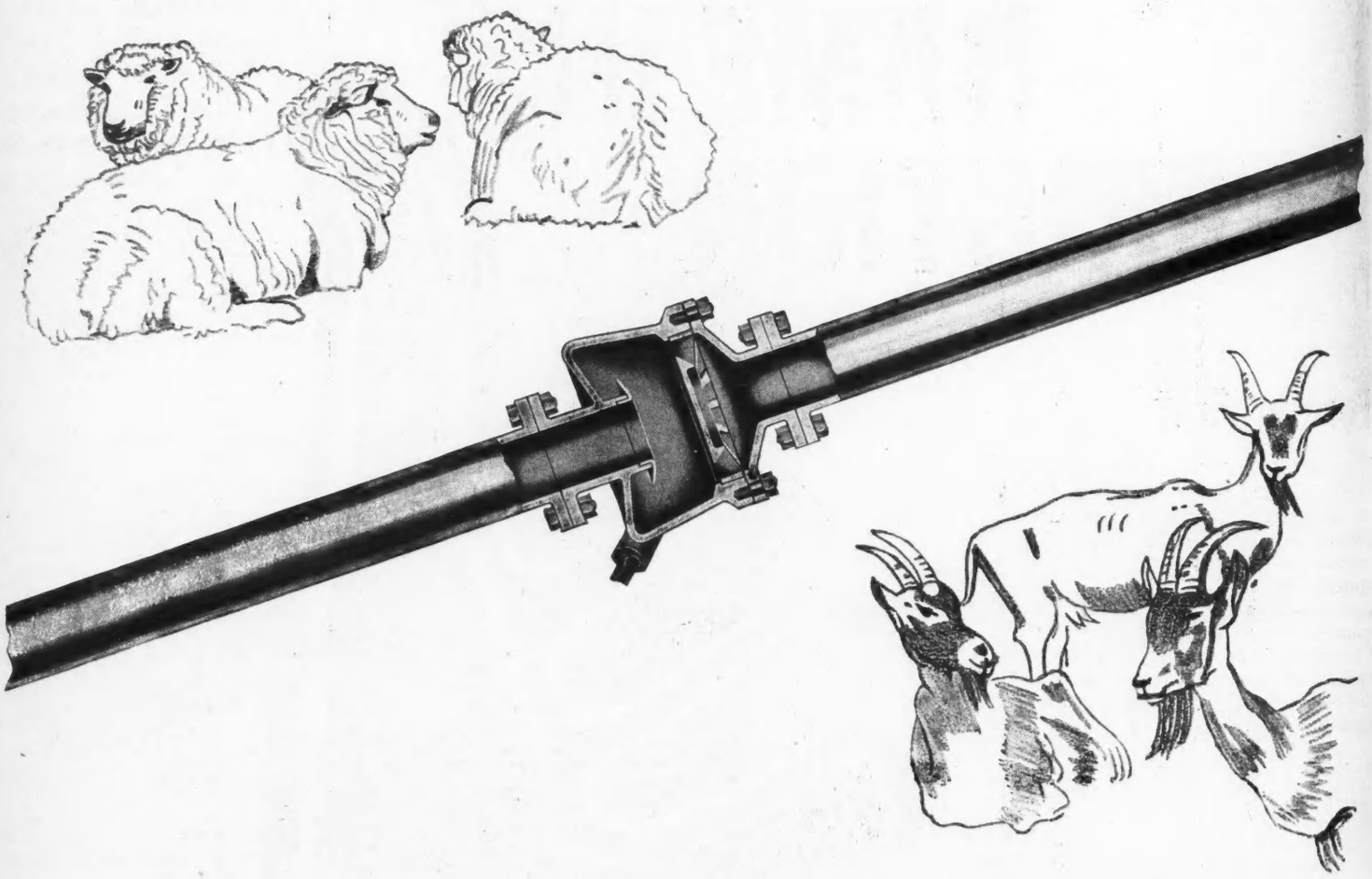

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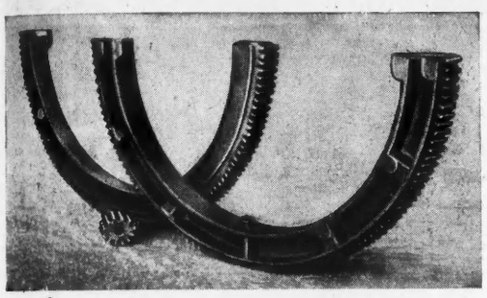

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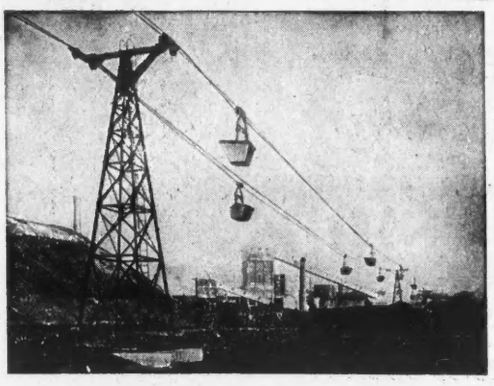

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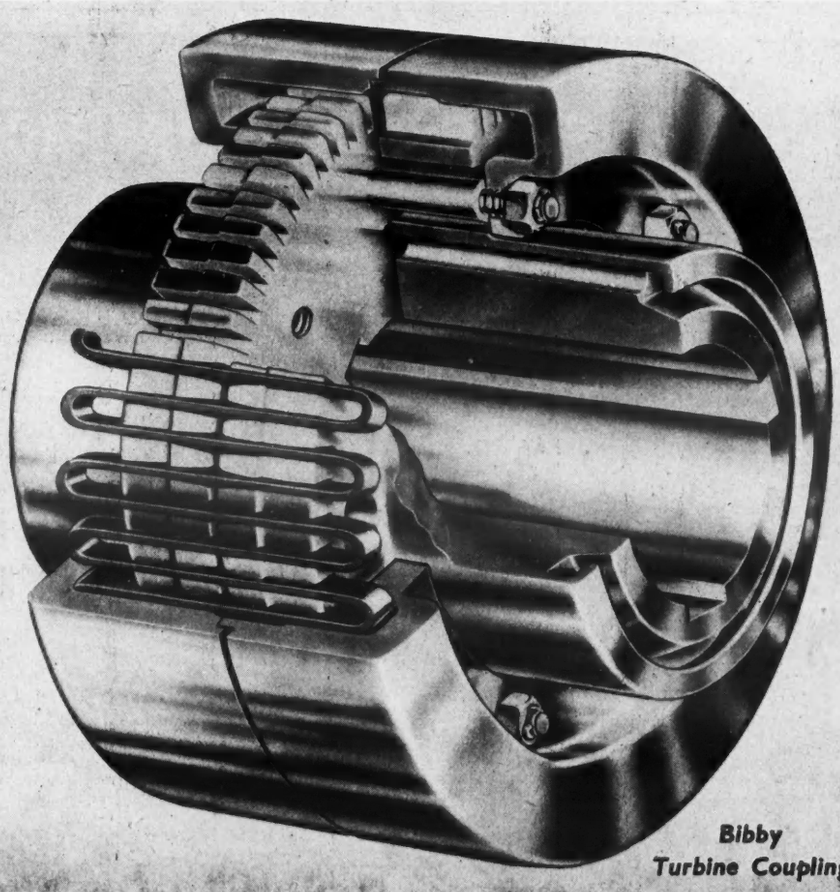

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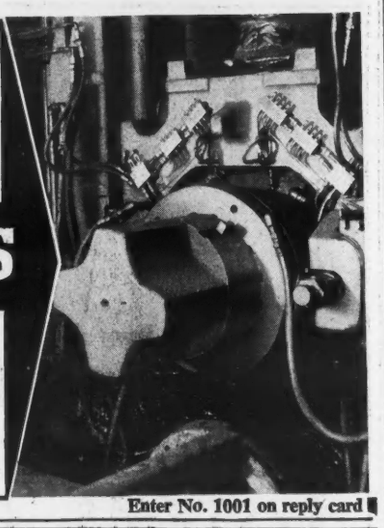

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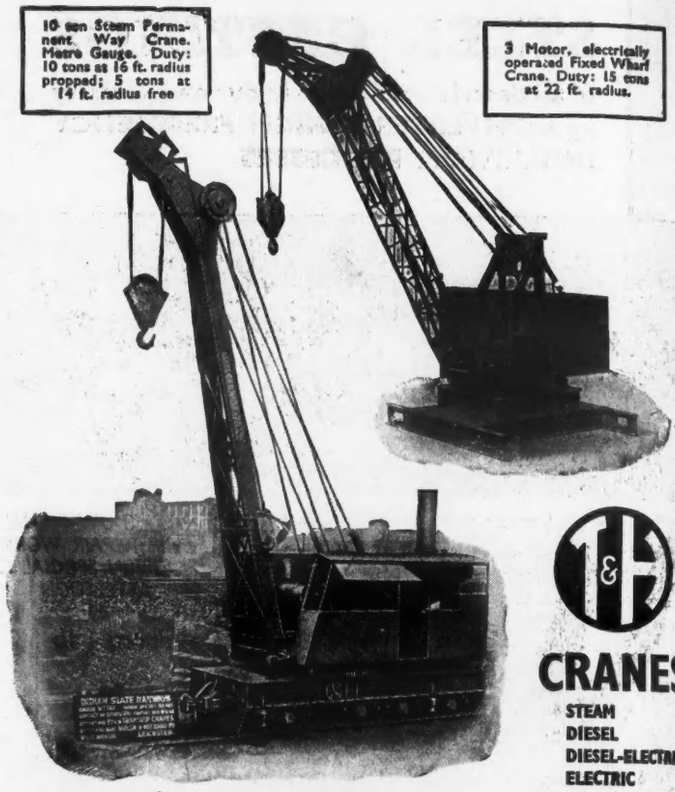

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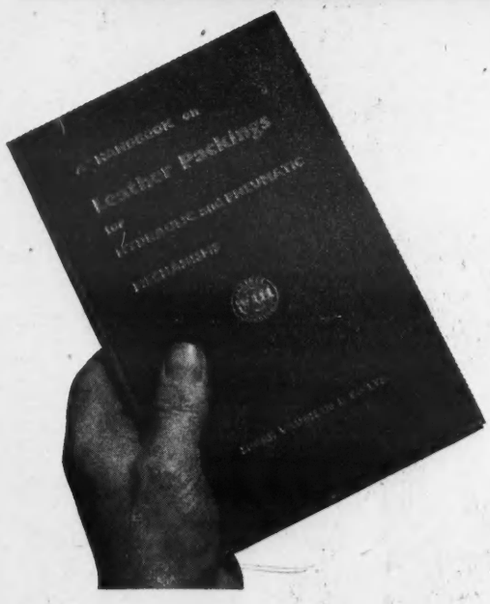

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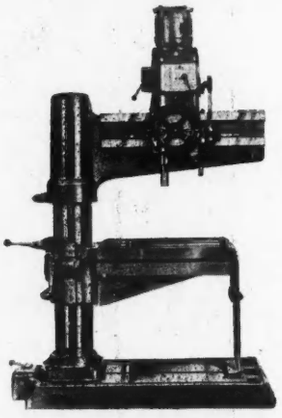

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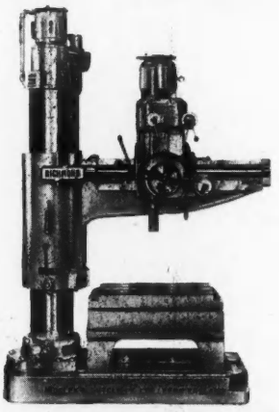

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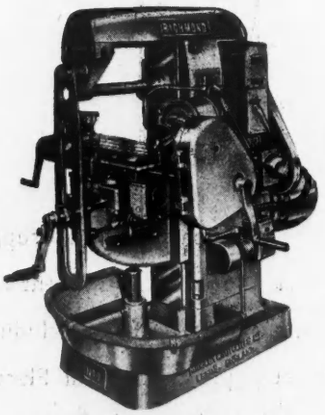

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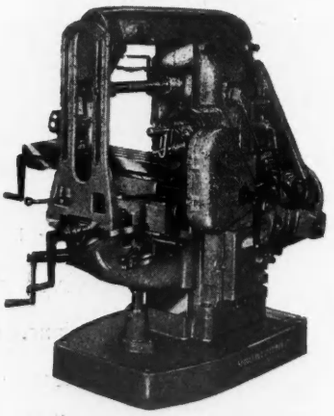
12 spindle speeds (Type 11) 26-600 R.P.M. 6 table feeds .005—.048 ins./rev.



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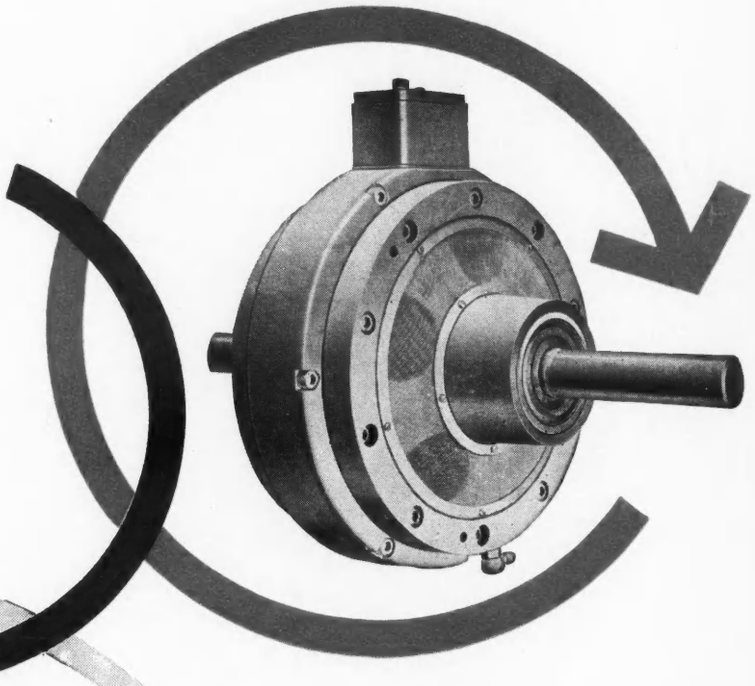

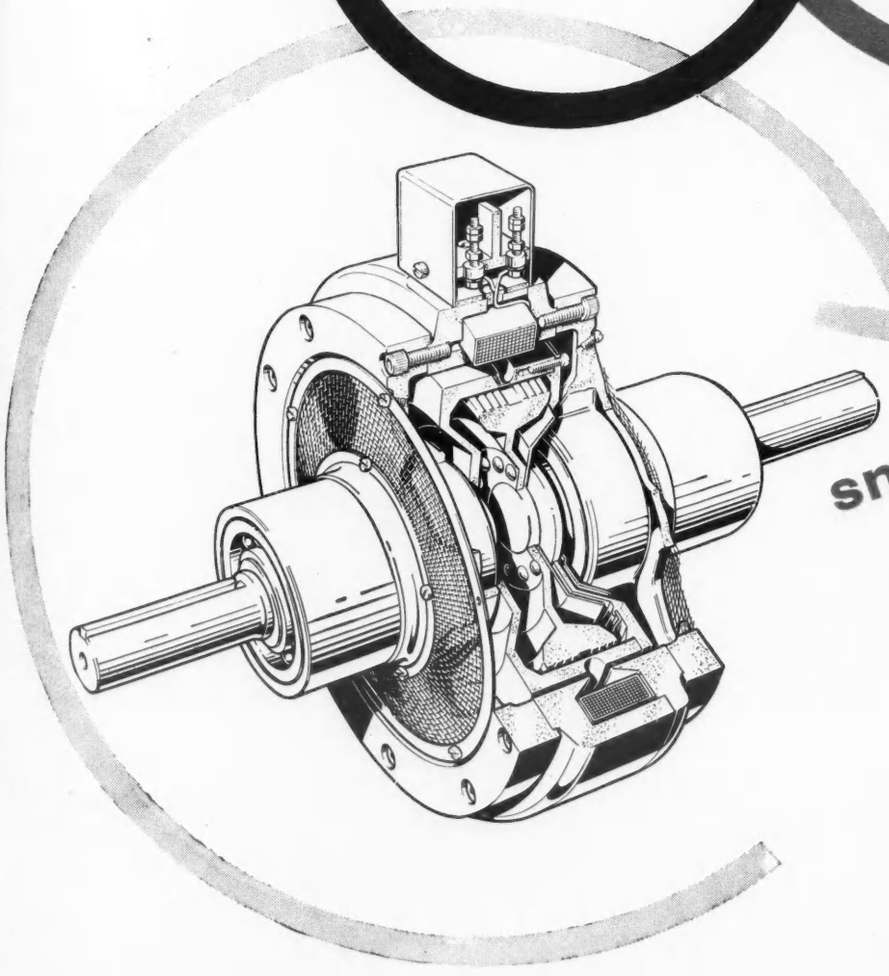

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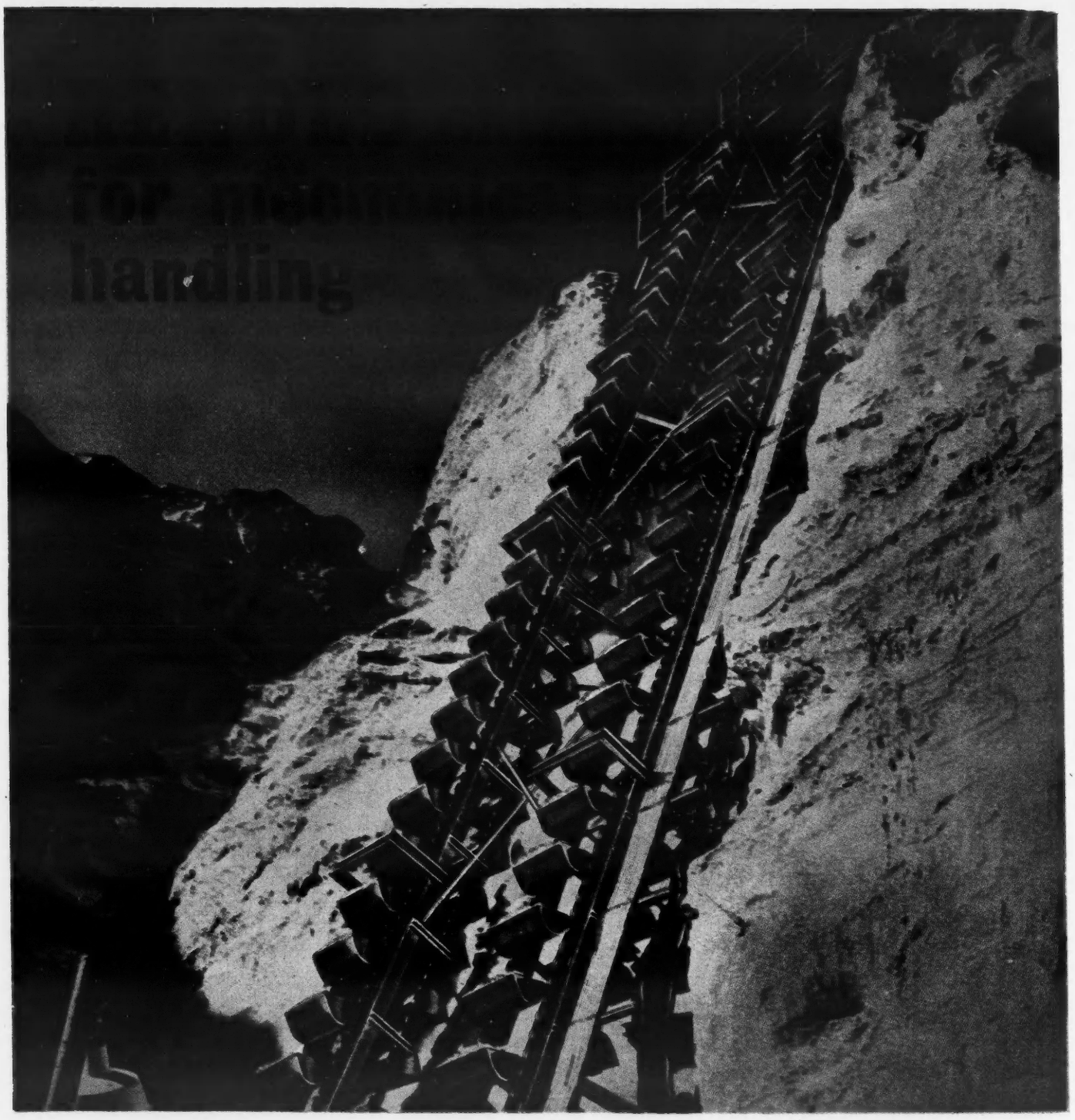

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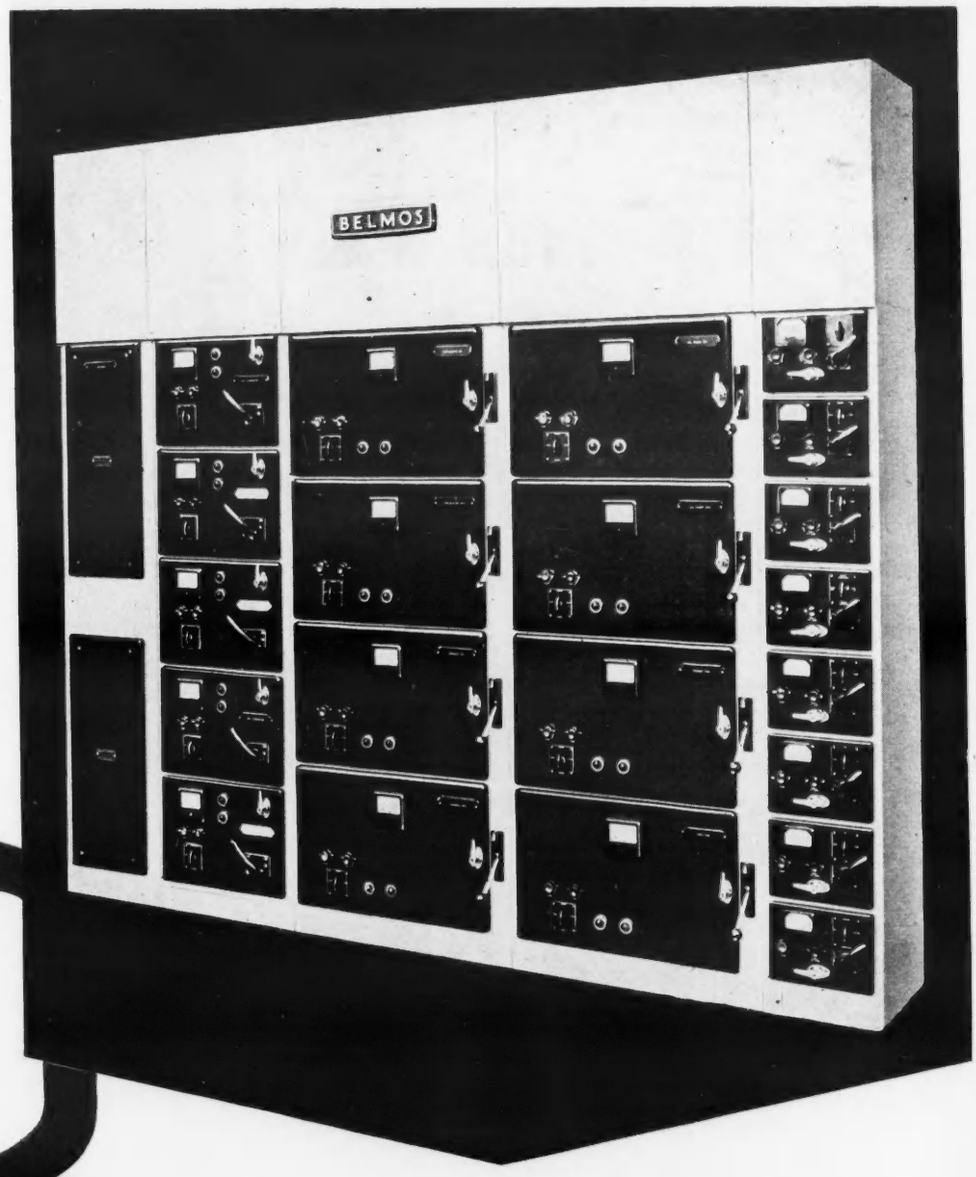

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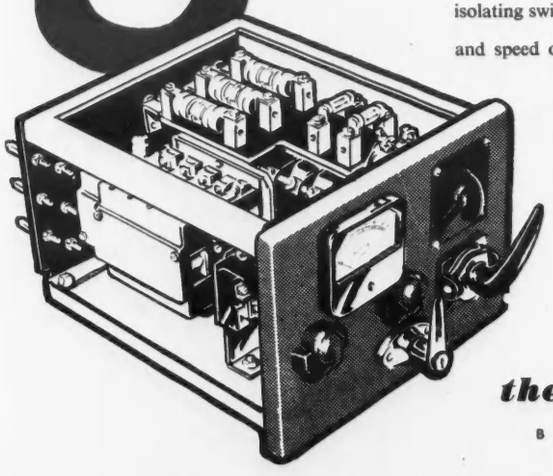
The Belmos ' H ' range eight-tier cubicle can accommodate eight direct-on-line starters suitable for the control of squirrel-cage motors up to 7½ h.p. at 440 volts. Each starter is fitted with a load-breaking isolating switch and is housed in a plug-in chassis for accessibility and speed of servicing.

This unit is fully described in leaflet K 500 which will be sent on request.



* The cubicles are designed to be grouped into flush-fronted control boards and, with the provision of simple local and remote control arrangements, are eminently suitable for group control of continuous processes. They can be lined up with the four- and five-tier cubicles of the ' G ' range, which house larger starters for motors up to approximately 80 h.p. at 440 volts.

Belmos

the Belmos company limited

BELLSH LL LANARKSHIRE

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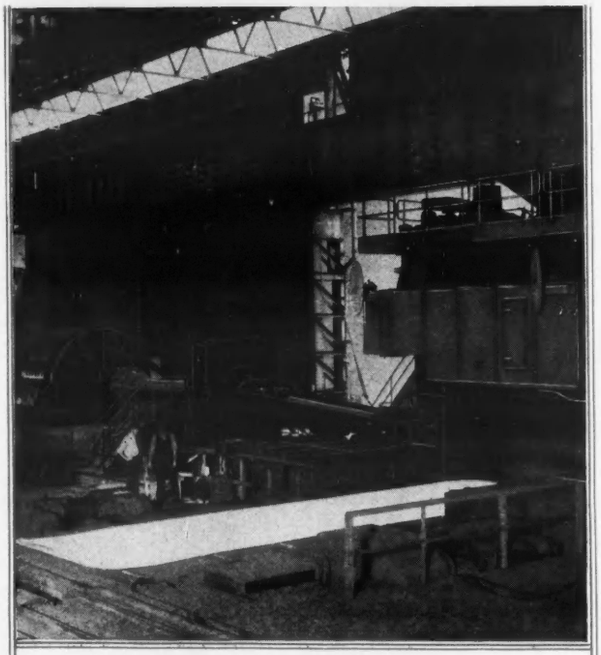
THE UNITED STEEL COMPANIES LTD



APPLEBY-FRODINGHAM

PLATES & SECTIONS

APPLEBY-FRODINGHAM STEEL COMPANY

SCUNTHORPE · LINCOLNSHIRE

A Branch of The United Steel Companies Limited

AF166

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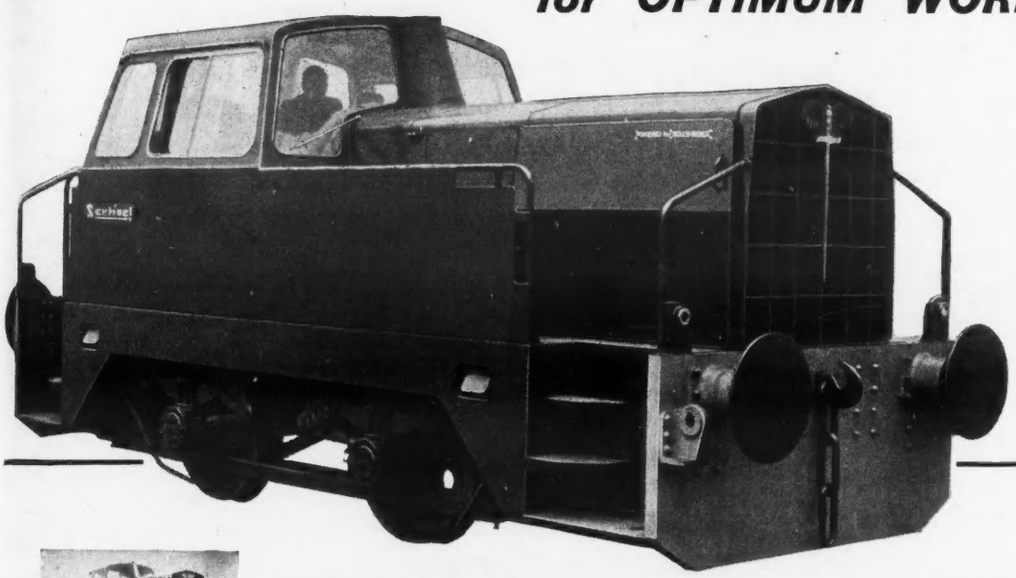
Sentinel industrial locomotives

POWERED BY ROLLS-ROYCE Diesels

for OPTIMUM WORKING EFFICIENCY



These are the locomotives that keep on going with low maintenance costs for the highest performance. Exceptional accessibility, complete all-round vision, bi-directional working and simple controls are features which guarantee the unsurpassed efficiency of the competitively priced Sentinel Rolls-Royce locomotives.

The Rolls-Royce 6-cylinder diesel engine coupled to a torque converter develops 233 b.h.p. (gross) at 1,800 r.p.m.

Send for this informative brochure containing all the essential facts and figures

SENTINEL (SHREWSBURY) LIMITED, SENTINEL WORKS, SHREWSBURY

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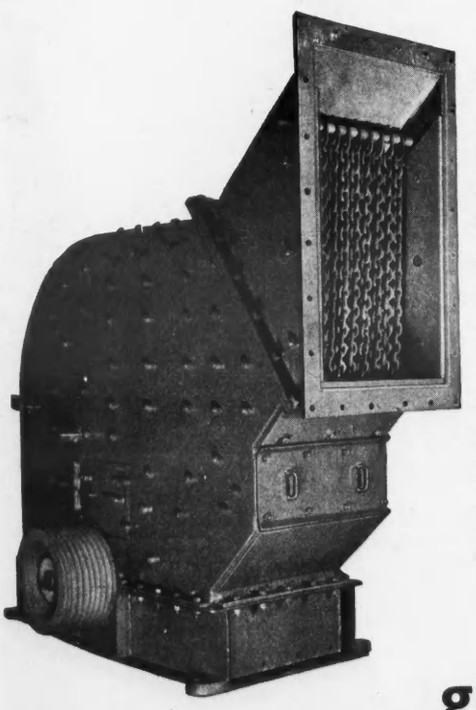
BIG ROCKS



Not even a Rock Buster could reduce "The Rock" but for crushing large industrial materials this massive B.J-D machine is invaluable. Its capacity is outstanding—36″ feeds to a 1½″ product, and up to 300 tons per hour. Available in several sizes, the Rock Buster is adaptable for a wide range of applications. When crushing hard, friable material you can't do better than give the job to a Rock Buster.

BJD

give 'em to a ROCK BUSTER

BRITISH JEFFREY-DIAMOND LTD., CRUSHER AND INDUSTRIAL DIVISION, THORNES, WAKEFIELD, YORKSHIRE

W.F. 5156

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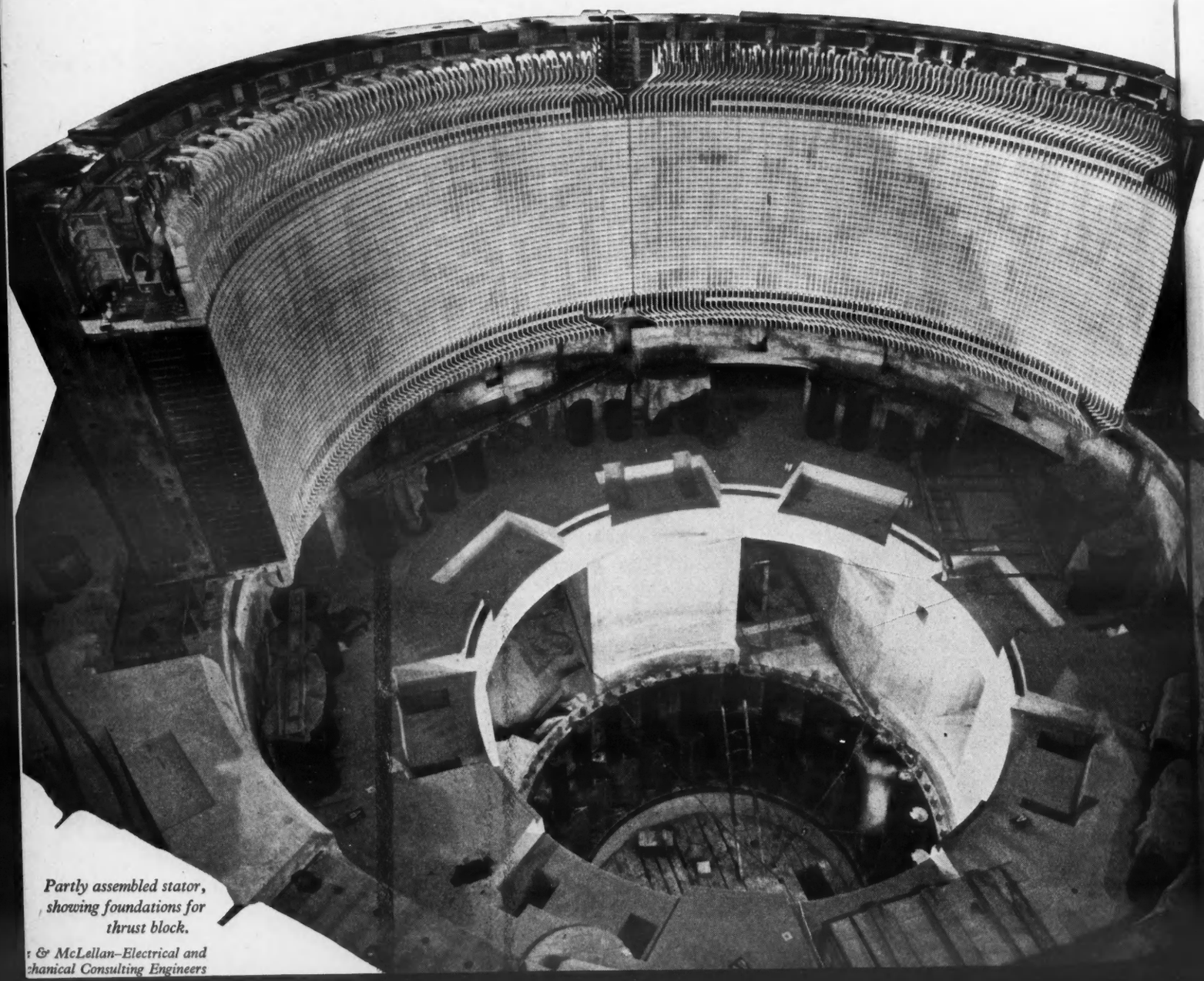
KARIBA—Electrical E

THREE HUNDRED MILES downstream from Victoria Falls, where vast power goes to waste in a magnificent display, the waters of the Zambesi are being harnessed to supply electricity to the whole of Northern and Southern Rhodesia. The world's largest man-made lake, with an area bigger than the whole of the county of Kent, will store sufficient water power to generate 8½ million MWh of electricity annually. When the first stage of the plan is completed in 1962 six 100-MW generators will be in operation. By the early 1970's it is planned to raise the total generating capacity to 1,500 MW.

From Kariba this power will be distributed to the growing industries and cities of the Rhodesias and particularly to the Copper Belt.

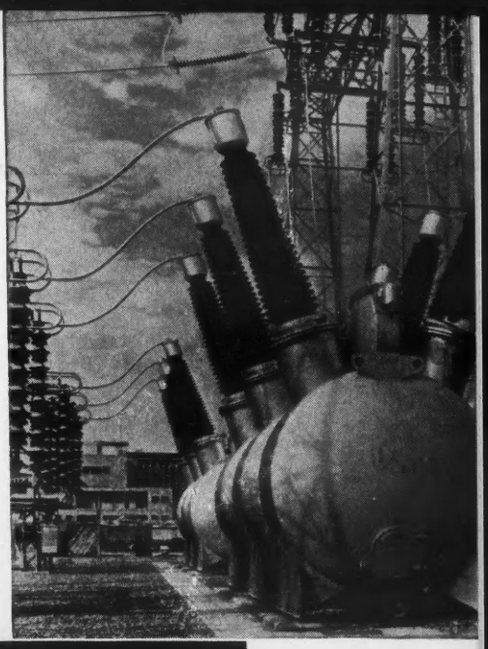
Much of the major electrical equipment for this great project is being supplied by AEI.



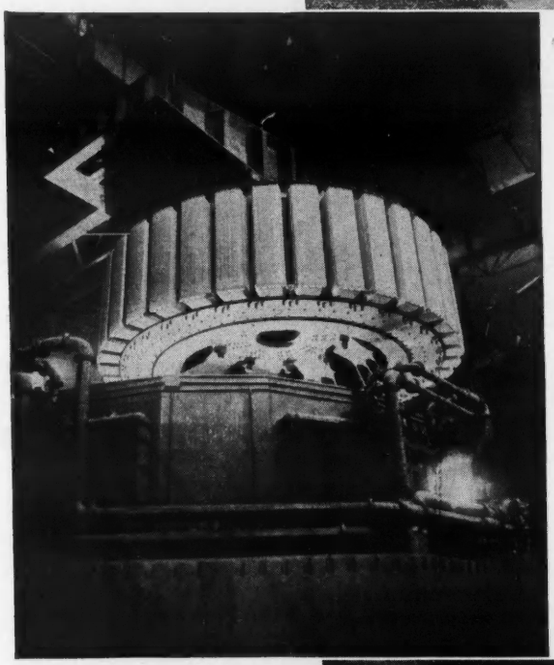
Partly assembled stator, showing foundations for thrust block.

: & McLellan–Electrical and chanical Consulting Engineers

Engineering on the Grand Scale



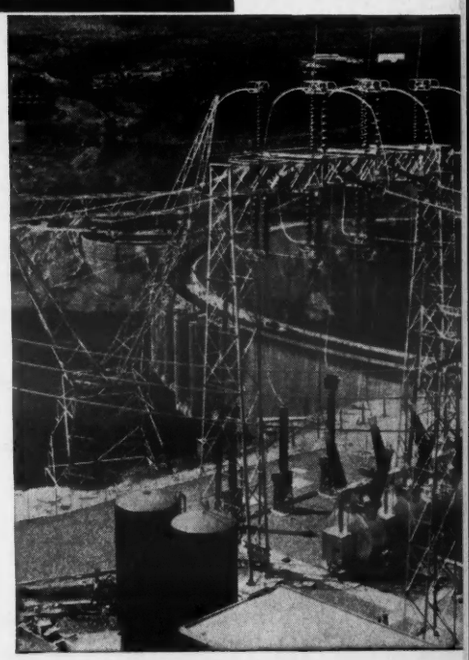
330 *kV* 7,500 *MVA* circuit breakers at Kariba switching station.



One of the six 100-*MW generator rotors being lowered into its stator.*

AT THE HEART OF THIS TREMENDOUS SCHEME are the six 100-MW AEI generators—the largest hydro-electric generators in Africa. Power is distributed at 330 kV which is the highest voltage to be used in the Southern hemisphere. For switching this power at Kariba and at the six sub-stations in Northern and Southern Rhodesia, AEI is to supply 25 oil circuit breakers, over 100 isolators and ancillary equipment.

AEI contracts also include the provision of 50 miles of cables, including control cables, co-axial and telephone cables and lead-covered cables for the underground power station.



A section of the 330-*kV switchyard at Kariba showing the equipment to control the feeder to Lusaka and Kitwe in Northern Rhodesia. The dam can be seen below.*

AEI

Associated Electrical Industries Limited

33 GROSVENOR PLACE, LONDON, S.W.1

AEI 211

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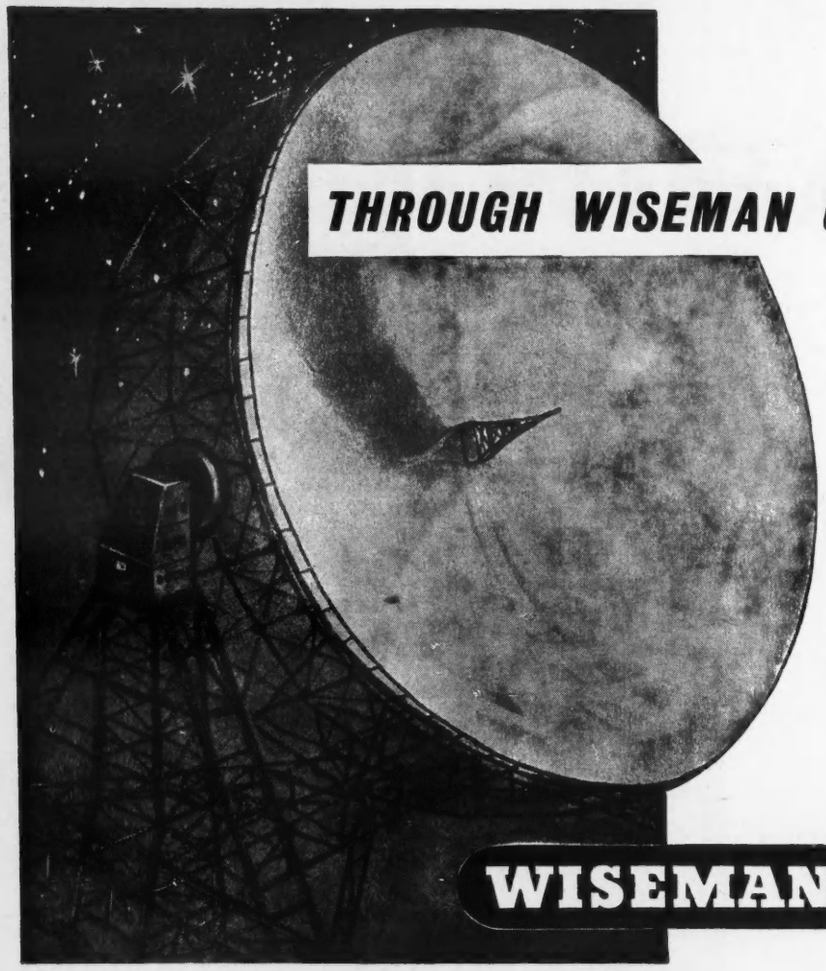
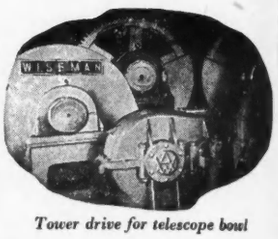


THROUGH WISEMAN GEARS INTO OUTER SPACE

At Jodrell Bank great masses are being moved smoothly and with precision by the application of Wiseman Standard Gear Units.

We are happy, in conjunction with the Brush Electrical Engineering Co. Ltd. and Husband & Co., who designed this Radio Telescope for Manchester University, to be associated with this great enterprise.

Bogey drive for azimuth movement



Tower drive for telescope bowl

Our engineers are always ready to co-operate with your staff in solving gear transmission problems.

WISEMAN

ALFRED WISEMAN & CO. LTD., Glover St., Birmingham, 9 VIC 2216-7

London Office: Carlisle House, 8 Southampton Row, W.C.1 HOL 7127

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CROSS British made components are consistently being specified for use in the products of the future. Where top standards are required CROSS components are essential, they are manufactured using a specialised hardening and tempering process, and are extremely accurate.

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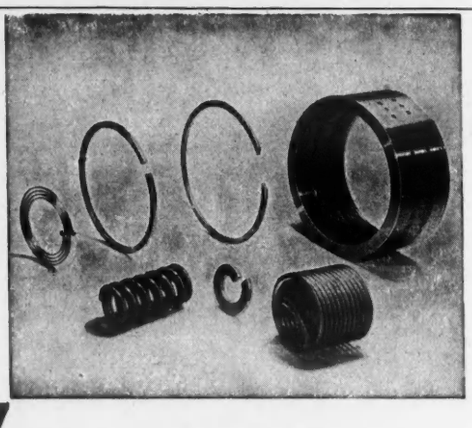

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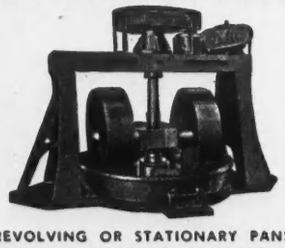

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PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN

Smedley Brothers. Ltd.
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Telephone: Belper 12

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No. 2 Valectric operating a 36" sluice valve.

VALECTRIC REGD.

VALVE ACTUATORS

'Valectric' Actuators are available for power operation of all sizes of sluice and butterfly valves, penstocks, etc. They are readily adapted to existing valves.

- AUTOMATIC OR REMOTE CONTROL
- SENSITIVE TORQUE LIMITER FOR FULL PROTECTION
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Head Office: Kearsley Chambers, Stoke-on-Trent. Tel: 48627
London Office: Hastings House, Norfolk St., Strand, W.C.2. Tel.: TEMple Bar 5705

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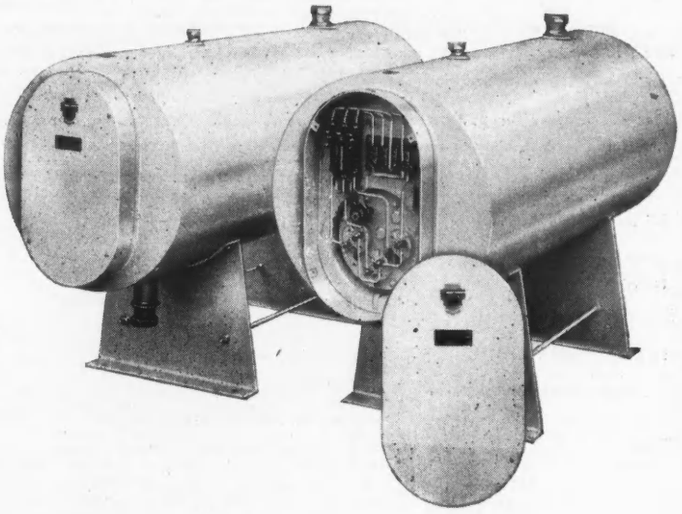
Heatrae of Norwich

HEATRAE CALORIFIERS

Heatrae Calorifiers are made in a wide range of water capacities and loadings. They can be used as independent units or alternatively as a heating unit to work in conjunction with a hot water storage system. Whatever the application, they are dependable and will give years of trouble free service.

Send us your enquiries.



HEATRAE LIMITED. NORWICH, NORFOLK, NOR 29A

Telephone: NORWICH 25131 (Private Exchange) Telegrams: HEATRAE · NORWICH

Manufacturers of Electric Water Heaters, Oil Heaters, Immersion Heaters, Urns, Towel Rails, Airing Cupboard Heaters, Electric Fires, Flameproof Heating Apparatus, Food Trolleys, Warming Plates, Air Heaters and Steam Heated Oil Heaters.

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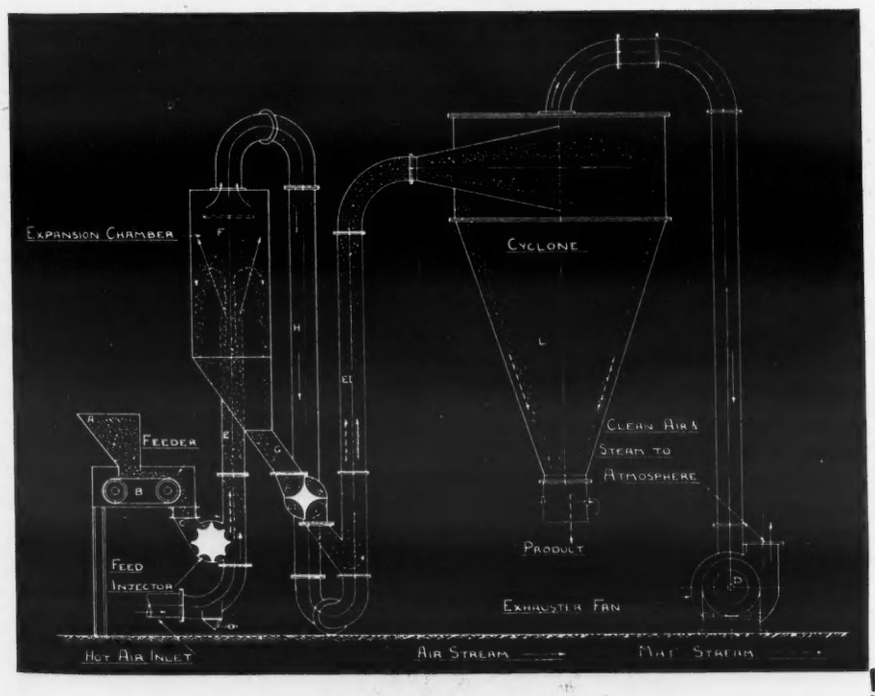

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The British 'Rema' Pneumatic Dryer is particularly suitable for small coals and materials easily damaged by breakage or overheating. Particles are separated and swept by hot gases giving a rapid transfer of moisture from the material to the air stream. Drying takes place in less than a minute.

The Dryer takes up little space and installations are in operation with capacities ranging from ½ ton to 100 tons per hour.

BRITISH 'REMA' MANUFACTURING CO. LTD.

PROPRIETORS: EDGAR ALLEN & CO. LTD.

ONE INDUSTRY ROAD · SHEFFIELD 9

Telephone: 42721/2

BR37/Eng.

To British 'Rema' Manufacturing Co. Ltd.
Imperial Steel Works, Sheffield 9

Please post data on "Pneumatic Dryers" to:

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POSITION .....

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CLASSIFIED ADVERTISEMENTS

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Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/–. **Inch Rate.** 54/– per single column inch and pro rata. 12 lines to 1 inch.
There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

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Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

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Use of Box Number. 2/– which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

UNIVERSITY OF AUCKLAND, NEW ZEALAND

SCHOOL OF ENGINEERING

SENIOR LECTURESHIPS

Applications are invited for the following appointments :

SENIOR LECTURESHIP IN CIVIL ENGINEERING. Candidates should be University graduates in Civil Engineering. A higher degree and/or professional experience would be an advantage. The person appointed will be attached initially to the Hydraulic Engineering section of the Department of Civil Engineering and the duties will include instruction in Water Supply and Sewage Disposal in which particular fields previous professional or academic experience would be an advantage.

SENIOR LECTURESHIP IN ELECTRICAL ENGINEERING. Candidates should be University graduates in Electrical Engineering : a higher degree would be an advantage. Previous lecturing experence is not essential.

SENIOR LECTURESHIP IN MECHANICAL ENGINEERING. Candidates should be University graduates in Mechanical Engineering. A higher degree would be an advantage. Previous lecturing experience is not necessary, especially if the candidate has had suitable professional experience in industry.

The salary scale for a Senior Lecturer is £1750 per annum rising to £2000 per annum by three annual increments, the first two of £100 and the third of £50. Commencing salary within this scale will be determined according to qualifications and experience. An allowance is made towards travel and removal expenses.

Further particulars and information as to the method of application should be obtained from the Secretary, Association of Universities of the British Commonwealth. 36, Gordon Square, London, W.C.1.

Applications close, in New Zealand and London, on 30th June, 1960. E9794

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE UPON TYNE

RAMBUSH STUDENTSHIP

Applications are invited for the above-mentioned STUDENTSHIP, of the value of £350 per annum, with remission of composition fee, which is available for post-graduate research in the Departments of Chemical, Mechanical and Civil Engineering, as a result of a gift from Power-Gas Corporation, Ltd.

The Studentship is open to Graduates of approved Universities, or holders of approved qualifications. It is tenable for two years, but may be renewed for a third year in special circumstances.

Forms of application and further particulars may be obtained from the undersigned, to whom completed application forms should be returned as soon as possible.

G. R. HANSON,
E9745 Registrar of King's College.

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

SENIOR LECTURERS AND LECTURERS

Applications are invited for SENIOR LECTURERS AND LECTURERS in the Department of Mechanical Engineering.

Applicants should have had industrial or research experience and, preferably, should possess a University degree. Encouragement will be given to undertake research and consulting work.

Salary scales : Senior Lecturer £1550 by £50 to £1750 ; Lecturer £1370 by £35 to £1550. The commencing salaries will be determined by previous experience and qualifications. The posts are pensionable.

Application forms and further information may be obtained from the Academic Registrar. (In reply quote 8/C.). E9760

PUBLIC APPOINTMENTS

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE UPON TYNE

GEORGE ANGUS STUDENTSHIP

Applications are invited for the above-mentioned STUDENTSHIP, of the value of £400 per annum, with remission of composition fee, which is available annually for post-graduate research in the Departments of Chemistry, Physics or Mechanical Engineering, as a result of a gift from Messrs. George Angus and Co., Ltd., of Newcastle upon Tyne.

The Studentship is open to graduates of approved Universities, or candidates hoping to graduate in June, 1960. It is tenable for two years, but may be renewed for a third year in special circumstances.

Forms of application and further particulars may be obtained from the undersigned, to whom completed application forms should be returned as soon as possible.

G. R. HANSON,
E9746 Registrar of King's College.

WEST RIDING COUNTY COUNCIL

SHIPLEY INSTITUTE OF FURTHER EDUCATION

ASSISTANTS

Applications are invited for the following posts :—

(a) ASSISTANT, Grade "B," to teach Mathematics, Science and Drawing, mainly to Day Release Engineering students preparing for Ordinary National Certificate and City and Guilds Examinations. Ability to help with some English and Social Studies will be an advantage. Applicants should have Higher National Certificate (Mechanical) or an equivalent qualification, and preferably have had training in teaching. Salary : £700 by £27 10s. to £1150, with allowances for approved qualifications, training and industrial experience.

(b) ASSISTANT, Grade "A," to teach mainly Engineering Shop Practice and Technology with a little Mathematics and Drawing, mainly to Day release students preparing for City and Guilds Craft examinations. Applicants should have had good workshop experience and hold the Final City and Guilds Certificate or an equivalent qualification. Salary : £520 by £27 10s. to £1000, with allowances for approved qualifications, training and industrial experience.

Application forms obtainable from W. H. Tomlinson, Town Hall, Shipley, to whom completed applications should be returned within 14 days of the appearance of this advertisement. E9736

KENT EDUCATION COMMITTEE

NORTH-WEST KENT COLLEGE OF TECHNOLOGY

ASSISTANT (GRADE B)

ASSISTANT (Grade B) required in the Mechanical Engineering Department, to teach Workshop Technology in the City and Guilds Machine Shop Engineering and the National Certificate courses. Other subjects according to qualifications.

Salary : £700 by £27 10s to £1150.

Forms of application and further details obtainable from the Principal at the College, Miskin Road, Dartford. E9737

WILTSHIRE EDUCATION COMMITTEE

NORTH WEST WILTSHIRE AREA COLLEGE OF FURTHER EDUCATION

GRADE "B" ASSISTANT FOR WORKSHOP PRACTICE

Applications are invited for a GRADE "B" ASSISTANT FOR WORKSHOP PRACTICE. City and Guilds of London Institute Machine Shop Engineering with classes up to Final.

Salary in accordance with the Burnham Technical Report. Additions made for training and qualifications.

Further details and forms of application may be obtained from the Principal, Cocklebury Road, Chippenham, Wilts. E9762

PUBLIC APPOINTMENTS

BRADFORD INSTITUTE OF TECHNOLOGY

Applications are invited for the position of

PRINCIPAL LECTURER IN MECHANICAL ENGINEERING

Candidates should be qualified to teach to final degree standard, preferably in Thermodynamics, and should have had adequate industrial experience.

The successful candidate will be expected to assist the Head of the Department with the administrative work of the Department, and will be encouraged to develop industrial contacts.

Salary scale : £1750 to £1900 per annum.

Previous industrial and research experience, at a suitable level, will be taken into account in fixing the commencing salary.

Further particulars and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford, 7.

HENRY PATTEN,
E9758 Clerk to the Governors.

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, ST. JOHN STREET, LONDON, E.C.1

LECTURERS AND SENIOR LECTURERS IN MECHANICAL ENGINEERING

These vacancies arise from the continued expansion of the College in Degree, Diploma in Technology and post-graduate studies.

Salary scales : Lecturer, £1408, rising to £1601. Senior Lecturer, £1588, rising to £1801.

Particulars and forms of application are available from the Secretary, to whom applications should be sent by 5th June. E9808

BIRMINGHAM REGIONAL HOSPITAL BOARD

APPOINTMENTS

The Board require Engineers in the following grades :—

(a) PRINCIPAL ASSISTANT ENGINEER : £1665 to £2035 per annum.
(b) GENERAL GRADE ENGINEER : £910 to £1600 per annum.
(c) ENGINEERING ASSISTANT : £600 to £1070 per annum.
(d) ENGINEERING DRAUGHTSMAN : £550 to £1250 per annum.

Interesting and responsible work in Regional Engineer's Department on design and installation of mechanical and electrical services for new hospitals and alterations to existing. Previous hospital experience desirable but not essential. Corporate membership of Chartered Engineering Institution essential for Principal Assistant grade.

Applications, giving three referees, to Secretary, 10, Augustus Road, Edgbaston, Birmingham, 15, by 3rd June, 1960, from whom further details can be obtained. E9810

CITY COUNCIL OF SINGAPORE

ELECTRICAL SUPERVISOR

Applications are invited for the appointment of ELECTRICAL SUPERVISOR on temporary Contract for 3 years in the City Water Department.

Qualifications required are :—

G.I.E.E., with 3 years' practical experience of H.T. Electrical plant and pumping plant, or H.N.C. (Electrical), with 5 years' experience as above, or C. and G. (Final) Electrical Engineering Practice (Parts I and II), with 7 years' experience as above.

Basic salary within scale $695 per month to $1280 p.m., with increments of $45 p.m. annually. Expatriation allowance payable in addition to basic salary, the current rates varying from $205 p.m. to $275, according to basic salary. $1 Malayan= approximately 2s. 4d. Starting salary according to qualifications and experience, and candidates are invited to state minimum salary acceptable.

Further details regarding quarters, paid air passages, leave, &c., are given in a memorandum which will be sent to qualified candidates, upon application to Messrs. Allen and Williams, 8, Clarges Street, Piccadilly, London, W.1, the Council's London Agents, to whom full applications in duplicate must be submitted by Tuesday, 24th May, 1960. E9726

PUBLIC APPOINTMENTS

AIR MINISTRY

ASSISTANT CIVIL ENGINEERS

Air Ministry requires ASSISTANT CIVIL ENGINEERS for engineering and administrative work on construction and maintenance of civil engineering and building projects (covering barracks, workshops, runways, roads, water supply, sewerage, drainage works, &c.) on R.A.F. and Civil Aviation Stations.

Starting salary : (According to age) £805 (at age 25) to £1095 (at age 34), thereafter rising annually to £1260, with increase for London and decrease for country districts. Additional increase of £75 per annum (within maximum of scale) after two years' approved service. subject to age then being 27 or over and Corporate Membership of Institution of Civil Engineers being held. Good opportunities for acquiring experience overseas with appropriate allowances of up to £1500 per annum in addition to salary. Appointments long-term with good prospects of pensionable positions and promotion. Five-day week, paid annual leave on rising scale, initially 4 weeks and 2 days.

Qualifications : A.M.I.C.E. or Sections I and II of Institution of Civil Engineers or B.Sc. (Eng.), and in addition have had at least 2 years' civil engineering experience on staff of Government Department, Local Authority or firm of Consulting Engineers or Contractors of good standing. Natural born British subjects.

Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E 184/0A. E9607

CITY OF BIRMINGHAM PUBLIC WORKS DEPARTMENT

MECHANICAL AND PUBLIC LIGHTING SECTION

PRINCIPAL ASSISTANT ENGINEER (MECHANICAL, HEATING AND VENTILATION)

Applications are invited for the post of PRINCIPAL ASSISTANT ENGINEER (Mechanical, Heating and Ventilation).

Salary in accordance with salary scales for senior officers—Grade "B," £1305/£1485 per annum.

Applicants must be Associate Members of the Institution of Mechanical, Electrical or Heating and Ventilating Engineers or hold the Higher National Certificate in Mechanical or Electrical Engineering (with five years' experience).

The duties of the post include the design of mechanical and heating services and installations in civic buildings, municipal offices, multi-storey flats, car parking garages, fire and police stations, schools, baths, salvage destructor plants, pump stations, &c.

Candidates must have had experience in the design, specification and supervision of contracts associated with the above work, and be experienced in the supervision and control of staff.

The appointment is permanent, superannuable and subject to a medical examination.

Applications, endorsed "Principal Assistant Engineer," stating qualifications, age and experience, together with the names of two referees, should reach the undersigned not later than the 28th May, 1960.

Canvassing disqualifies.

HERBERT J. MANZONI,
City Engineer and Surveyor.

Civic Centre,
Birmingham, 1.
2nd May, 1960. E9738

LUTON WATER COMPANY

ENGINEERING ASSISTANT

The Company has a vacancy for a qualified ENGINEERING ASSISTANT at a commencing salary of £950 per annum, increasing to £1150 per annum by five annual instalments. In addition to normal expansion, a capital works programme of some £3,000,000 is anticipated over the next 5-6 years. The position is permanent, with pension and life assurance scheme, and a large flat at moderate rental is immediately available. Applications, giving full personal details, qualifications and experience, together with names of two persons to whom references may be made, should be received by the undersigned by May 31st, 1960.

A. J. WATKINS, M.I.C.E.,
Engineer and Manager.

Luton Water Company,
Crescent Road,
Luton, Beds. E9669

PUBLIC APPOINTMENTS

DEPARTMENT OF MAIN ROADS

NEW SOUTH WALES, AUSTRALIA

CIVIL ENGINEERS

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination, and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56, Strand, London, W.C.2. E9784

HER MAJESTY'S OVERSEAS CIVIL SERVICE

GOVERNMENT OF HONG KONG

MECHANICAL ENGINEERS, PUBLIC WORKS DEPARTMENT

To supervise workshops engaged in the repair of motor vehicles, refrigerators, electrical appliances, &c.

Pensionable appointment. Salary according to experience, within the range £1500–£2865. Free passages. Rented quarters.

Candidates, under 45 years of age, must be A.M.I.Mech.E., with considerable experience in workshop practice and management, and preferably with knowledge of electrical engineering.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/51/024/D4. E9753

NORTH EASTERN GAS BOARD

HEAD OFFICE

CIVIL AND STRUCTURAL ENGINEER

Applications are invited for the above position in the Chief Engineer's Office at the Head Office of the Board at a salary within Group D of the National Salaries Table for Senior Gas Officers (£1483 to £1683 per annum).

The duties of the position are concerned with all aspects of civil and structural engineering in the Area of the Board, including buildings, steel structures, foundations for plant and buildings, reinforced concrete structures, roads and drainage.

The successful applicant will be in charge of a small qualified technical staff and will be responsible for the carrying out of projects from inception to completion at site.

Applicants must be Corporate Members of the Institution of Civil Engineers, or other Professional Engineering body, or possess equivalent technical qualifications. Previous experience in the Gas Industry is desirable, but not essential.

The successful applicant will be required to pass a medical examination and join the Board's Staff Pension Scheme.

Application forms may be obtained from the Chief Engineer, North Eastern Gas Board, Head Office, Bridge Street, Leeds, 2, and should be returned to him not later than 23rd May, 1960. E9789

GUILDFORD, GODALMING AND DISTRICT WATER BOARD

CAPITAL WORKS SECTION

APPOINTMENT OF ENGINEERING DESIGNER-DRAUGHTSMAN (NON-ESTABLISHED)

Applications are invited for the above post in the Chief Engineer's Department.

Candidates should have had considerable experience in the preparation of working drawings and Bills of Quantities for civil engineering works, with particular reference to reinforced concrete water-retaining structures. The possession of a Higher National Certificate or other qualification would be an advantage. Intending candidates may obtain further information from the Chief Engineer, "Branksome," Filmer Grove, Godalming, Surrey.

The salary will be within Grade III (£880 to £1065) according to experience.

Applications, giving details of education, age, training, experience, &c., together with the names of two referees, should reach the undersigned not later than Thursday, 26th May, 1960.

Housing accommodation is not available at present, but a one-bedroom flat may be available on a service tenancy later in the year.

HERBERT C. WELLER,
Clerk to the Board.
Municipal Offices,
High Street, Guildford. E9792

PUBLIC APPOINTMENTS

RHODESIA RAILWAYS

VACANCIES FOR CIVIL ENGINEERS

Vacancies exist on the Permanent Staff for Civil Engineers for service in the Chief Engineer's Department of the Rhodesia Railways. Normally applicants under 30 years of age will be given preference.

Applicants under 25 years of age should possess a degree in Civil Engineering.

Applicants over 25 years of age should possess a degree in Civil Engineering and be prepared to sit Part III of the examination for Corporate Membership of the Institution of Civil Engineers within a reasonable period, or should be Corporate Members of the Institution.

Applications will also be considered from men who have passed Part I and II of the Institution examinations, for appointment to the grade of Technical Assistant until such time as they become Corporate Members and are, therefore, eligible for transfer to the Professional Grade.

The salary scale for Assistant Engineers is £1000 to £1800 per annum, plus a Cost of Living Allowance, at present calculated on 12 per cent of the basic salary, subject to a maximum of £13 15s. per month. The commencing salary will depend upon previous experience of the applicant. The annual increments in the above scale are as follows :

£1000 by £100 to £1200.
£1200 by £50 to £1500.
£1500 by £100 to £1800.

Further advancement to the grade of District Engineer on the salary scale of £2000 by £100 to £2300 per annum is possible as and when vacancies occur. Promotion to these posts is by selection.

Membership of the Contributory Pension Fund and Medical Fund is obligatory and the usual Railway privileges in respect of travelling concessions, leave, &c., will apply.

Income Tax in the Federation is not unreasonable and, at the present time, a married man with one child, earning £1100 per annum, would not be liable.

Housing is provided at a moderate rental for married Engineers ; the rental payable is £7 10s. per month for Officers in receipt of a salary under £1700 per annum, and £10 per month for Officers in receipt of higher salaries.

Full particulars with regard to age, training, qualifications and experience should be submitted, together with copies of recent testimonials, to :

The London Agent,
Rhodesia Railways,
241, Salisbury House,
London Wall, London, E.C.2,

from whom full details regarding conditions of service may be obtained. E9766

RHODESIA RAILWAYS

VACANCIES FOR SIGNALS AND COMMUNICATIONS ENGINEERS

Vacancies exist on the Permanent Staff for SIGNALS AND COMMUNICATIONS ENGINEERS for service in the Chief Engineer's Department of the Rhodesia Railways.

Preference will be given to applicants who have had previous experience in the design, installation and maintenance of modern colour light signalling and/or telecommunication systems with a Railway Administration or with a firm of equipment manufacturers.

Applicants should hold a degree in Electrical Engineering at a recognised University or be Corporate Members of the Institution of Electrical Engineers. Applicants who have passed Parts I and II of the Institution examinations will be considered for appointment to the grade of Technical Assistant until such time as they become Corporate Members and are, therefore, eligible for transfer to the Professional Grade. Successful candidates will be expected to become Corporate Members of the Institution of Railway Signal Engineers in due course.

The salary scale for Assistant Engineers is £1000 to £1800 per annum, plus a Cost of Living Allowance at present calculated on 12 per cent of the basic salary, subject to a maximum of £13 15s. per month. The commencing salary will depend upon previous experience of applicants. The annual increments in the above scale are as follows :

£1000 by £100 to £1200.
£1200 by £50 to £1500.
£1500 by £100 to £1800.

Further advancement to the grade of District Signals and Communications Engineer on the salary scale £1800 by £100 to £2100 is possible, as and when vacancies occur. Promotion to these posts is by selection.

Membership of the Contributory Pension Fund and Medical Fund is obligatory and the usual Railway privileges in respect of travelling concessions, leave, &c., will apply.

Income Tax in the Federation is not unreasonable, and at the present time, a married man with one child earning £1100 per annum, would not be liable.

Housing is provided at a moderate rental for married Engineers ; the rental payable is £7 10s. per month for Officers in receipt of a salary under £1700 per annum, and £10 per month for Officers in receipt of higher salaries.

Full particulars with regard to age, training, qualifications and experience should be submitted together with copies of recent testimonials to :

The London Agent,
Rhodesia Railways,
241, Salisbury House,
London Wall,
London, E.C.2,

from whom full details regarding conditions of service may be obtained. E9765

PUBLIC APPOINTMENTS

ROAD RESEARCH LABORATORY (D.S.I.R.), HARMONDSWORTH, MIDDLESEX

CIVIL ENGINEERS, PHYSICISTS, MATHEMATICIANS, STATISTICIANS

Road Research Laboratory (D.S.I.R.), Harmondsworth, Middlesex, requires CIVIL ENGINEERS, PHYSICISTS, MATHEMATICIANS, STATISTICIANS in the Senior Scientific/Scientific Officer grades, for work in Tropical Section of R.R.L., as follows : (a) Civil Engineers and Physicists for work on problems of soil mechanics, road construction and maintenance in overseas territories ; (b) Civil Engineers, Mathematicians and Statisticians for work on road traffic and transport, and on road safety problems of overseas territories. Work based at Road Research Laboratory at Harmondsworth, and involves regular visits to overseas territories, with, in some cases, postings to overseas territories for periods of 1-2 years on specific projects. Qualifications : 1st or 2nd Class Honours degree. At least 3 years post-graduate experience required for S.S.O. (Minimum age 26.) Starting salaries with range S.S.O. £1233 to £1460 ; S.O. £655 to £1150. Normal prospects of promotion to Principal Scientific Officer in mid-thirties (range up to £2120) with possibilities of higher posts. Five-day week. Applications from overseas candidates will be considered. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E.450/9A. E9759

WATFORD CORPORATION

WATER DEPARTMENT

ASSISTANT ENGINEER

ASSISTANT ENGINEER, Grade A.P.T. I—£610–£765 per annum.

Applicants should have general engineering experience, preferably with a Water Undertaking. Commencing salary according to experience. Housing accommodation cannot be provided.

Applications to J. R. Collins, A.M.I.C.E., A.M.I.W.E., Water Engineer and Manager, Town Hall, Watford, Herts. Closing date 19th May, 1960. E9752

TENDERS

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, W.3, invites TENDERS for the SUPPLY of :—

TENDER REF. No. 18176/59/BMB/HAL. INTERNAL GRINDING MACHINE—Bore Grinding capacity 300 m/m to 600 m/m Dia.—grinding depth 300 m/m—length of gap 600 m/m.

The Tender forms with schedules and specifications which are returnable on 30th May, 1960, may be obtained from the above office (Co-Ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for Tender should specify the above reference. E9769

CITY OF SHEFFIELD

WATER UNDERTAKING—YORKSHIRE DERWENT SCHEME

TENDER ENQUIRY FOR RIVER CROSSINGS

The Corporation propose to invite TENDERS for the LAYING OF TWIN 42in. –38in. WELDED STEEL PIPES under the Rivers Ouse and Aire in the West Riding in navigable waters.

Invitations will be confined to those firms who have recently and successfully carried out works of a similar nature and size. Applications to be placed upon a list of selected firms, accompanied by details of similar works carried out since 1945, should be sent at once to the General Manager and Engineer, Waterworks Office, Town Hall, Sheffield, 1, from whom further details may be obtained.

JOHN HEYS,
Town Clerk.
5th May, 1960. E9800

INDIA SUPPLY MISSION

The Office of India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington, 8, D.C., United States of America, invites TENDERS for the following :—

TENDER ENQUIRY No. S.E. 158.

For the SUPPLY of ONE 75-ton (metric) INDOOR ELECTRIC OVERHEAD TRAVELLING CRANE, span 37½m. approx. For Chandrapura Thermal Power Station. Required by Damodar Valley Corporation.

Specifications, &c., relative to the above specification, can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of £1 15s. 8d. per Tender, and is not refundable. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington, 8, D.C., United States of America, so as to reach them by 19th June, 1960.

Specimen copy of the above enquiry can be seen at India Store Department, Engineering Branch, Bromyard Avenue, Acton, London, W.3, under the following reference : S.4226/59/NSC/ENG.2. E9768

TENDERS

CITY OF NOTTINGHAM

WATER DEPARTMENT

ANNUAL CONTRACTS—1960-61

CAST IRON PIPES—Classes "C" and "D" (including ordinary sand cast, sand spun and spun iron).
SPECIAL CASTINGS up to and including 6in—Class "CD."
SPECIAL CASTINGS over 6in.—Class "CD."
IRREGULAR SPECIAL CASTINGS—Class "CD."
MISCELLANEOUS IRON CASTINGS.
HYDRANTS AND SLUICE VALVES.
GUN METAL FITTINGS.

The Nottingham Corporation invite TENDERS for the SUPPLY of the above stores and materials, for the 12 months ending 30th June, 1961.

Copy of the general conditions, specifications, forms of Tender, &c., for any of the contracts abovementioned will be forwarded on application to Mr. B. W. Davies, Engineer and General Manager, Water Department, Castle Boulevard, Nottingham.

Tenders to be sent to me in the envelope provided not later than noon on Friday, the 27th May, 1960.

T. J. OWEN,
Town Clerk.
Guildhall,
Nottingham. E9782

CITY OF SHEFFIELD

WATER UNDERTAKING—YORKSHIRE DERWENT SCHEME

TENDER ENQUIRY FOR PIPELAYING

The Corporation proposed to invite TENDERS for the LAYING of the PIPELINE of the Yorkshire Derwent aqueduct between Elvington (near York) and Sheffield. This is to be a welded steel line, 42in. to 36in. diameter, and about 40 miles long ; to be laid in two years, starting about 1962.

Invitations will be confined to those firms who have recently and successfully carried out works of a similar nature and size. Applications to be placed upon a list of selected firms, accompanied by details of similar works carried out since 1945, should be sent at once to the General Manager and Engineer, Waterworks Office, Town Hall, Sheffield, 1, from whom further details may be obtained.

JOHN HEYS,
Town Clerk.
5th May, 1960. E9798

KINGDOM OF THAILAND

ROYAL IRRIGATION DEPARTMENT

BANGKOK, THAILAND

INVITATION FOR BIDS—NO. YSC-3-2

The Royal Irrigation Department of the Kingdom of Thailand hereby invites SEALED WRITTEN BIDS for FURNISHING MATERIALS and for CONSTRUCTING and INSTALLING the 230kV Transmission Line from the city of Bangkok to the Bhumiphol Hydro-electric Power Plant, Thailand, for the Yanhee Multipurpose Project, Kingdom of Thailand, in accordance with the Contract Documents for 230kV Bangkok-Bhumiphol Transmission Line.

The Contract Documents for the 230kV Bangkok-Bhumiphol Transmission Line will cover the furnishing of all materials and for the complete construction of this 230kV line. The line will comprise approximately 430 kilometres (267 miles) of single circuit line with two overhead ground wires and using double circuit steel towers (one side strung). A few single-circuit towers will be utilised for this line at special locations.

Invitations for Bids will be issued in May, 1960, and will be opened in August, 1960. Copies of Contract Documents, Invitation for Bids—No. YSC-3-2, 230kV Bangkok-Bhumiphol Transmission Line, may be obtained by qualified bidders on written request to : Royal Irrigation Department, Attention : Thai Liaison Engineer, c/o Engineering Consultants, Inc., 1901 South Navajo Street, Denver 23, Colorado.

Each request must be accompanied by a cheque or money order, payable to the Royal Irrigation Department, in the amount of U.S. $25.00 for each copy of the Contract Documents requested. The remittance is non-returnable.

M. L. XUJATI KAMBHU,
Director General.
Royal Irrigation Department,
Kingdom of Thailand,
Bangkok, Thailand. E9814

SHORTLAND COUNTY COUNCIL

NEWCASTLE, NEW SOUTH WALES

SPECIFICATION NO. 7/1960

TENDER for SUPPLY and DELIVERY of 4700ft. Paper Insulated Lead Covered SINGLE WIRE ARMOURED CABLE for working pressure of 11,000 volts and 2100ft. Paper Insulated Lead Covered SINGLE WIRE ARMOURED CABLE for 650 volts working pressure.

Tenders are hereby invited from manufacturers in U.K. for the supply and delivery of the abovementioned Cable.

Copies of the specification may be obtained from Ranald J. Harvey and Partners, 34, Victoria Street, Westminster, London, S.W.1, in payment of 5s.

Tenders endorsed "Contract S.C.C. 223," are to be sealed and delivered to the office of Ranald J. Harvey and Partners before noon on Thursday, 16th June, 1960. E9754

Classified Advts. continued on page 114

TENDERS

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS (RAILWAY BOARD)

INDIAN RAILWAYS' REQUIREMENTS OF POWER-OPERATED TIE TAMPERS

The Ministry of Railways (Railway Board), Government of India, propose to obtain from established or prospective and reliable manufacturers SUPPLY of POWER-OPERATED TIE TAMPERS for the maintenance of Railway Tracks.

(2) The relevant Tender documents are obtainable from the Research Designs and Standards Organization, Ellerslie, Simla East (India) on payment of Rs.2.00 np (3s.) per copy.

(3) Quotations should reach the Director, Railway Stores, Railway Board, State Entry Road, New Delhi not later than 16.00 hours on 1st June, 1960. E9781

INDIA STORE DEPARTMENT

The Office of the Director General, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the following :—

(a) ROLLING MACHINES FOR AIRCRAFT SECTIONS.
(b) HYDRAULIC SKIN STRETCHING MACHINE, 60-Ton.
(c) STRAIGHT STRETCHING MACHINE for BARS AND SECTIONS.

Specifications, &c., can be obtained from the Co-ordinate Branch, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, at a cost of 10 shillings per Tender enquiry and is not refundable. Tenders are to be returned to the above address by Thursday, 2nd June, 1960. Specimen copy of the above enquiries can be seen at Engineering Branch, India Store Department, under the following references :—

(a) 2830/59/48/SSB/ENG.3.
(b) 2830/59/51/SSB/ENG.3.
(c) 2830/59/52/SSB/ENG.3.

E9767

CITY OF SHEFFIELD

WATER UNDERTAKING—YORKSHIRE DERWENT SCHEME

TENDER ENQUIRY FOR CONSTRUCTION OF TREATMENT WORKS

The Corporation propose to invite TENDERS for the CONSTRUCTION of the Building and Civil Engineering Works of a WATER TREATMENT PLANT at Elvington, near York. These works will comprise a River Intake, R.C. Tanks, Filters, Bunkers and Silos, and Buildings housing the Plant and Pumps to handle flows of 15 m.g.d.

It is intended that construction should start in 1962, and must proceed in close collaboration with a number of specialist firms on the site at the same time. Works are to be completed in two years.

Invitations will be confined to those firms who have recently and successfully carried out works of a similar nature and size. Applications to be placed upon a list of selected firms, accompanied by details of similar works carried out since 1945, should be sent at once to the General Manager and Engineer, Waterworks Office, Town Hall, Sheffield, 1, from whom further details may be obtained.

JOHN HEYS,
Town Clerk.

5th May, 1960. E9799

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the supply of :

TENDER REF. NO. 20055/59/NEN/HAL.2.

ONE OFF—FRICTION SCREW PRESS—1000 tons capacity—Stroke 18in.

The Tender forms with Schedules and Specifications which are returnable on the 16th June, 1960, may be obtained from the above office (C.D.N. Branch) on payment of a fee of ten shillings (not refundable) for each Tender.

The applications for Tenders should clearly state the above reference number. E9809

KERALA STATE ELECTRICITY BOARD

TENDER NO. H.E.P.2/60—EXTENSION NOTICE

Sub :—Sholayar Hydro Electric Project—SUPPLY and ERECTION of PENSTOCK PIPES and ACCESSORIES.

The last date of receipt of the above Tender, due on 9th May, 1960, is hereby further extended up to 3 p.m. on 31st May, 1960. E9780

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

EDUCATIONAL

ADMINISTRATIVE COUNTY OF CARMARTHEN

THE THOMAS AND ELIZABETH WILLIAMS SCHOLARSHIPS

(LLANELLY SCHOOL DISTRICT)

Applications are invited for POST-GRADUATE SCHOLARSHIPS from University Graduates and also persons possessing professional or technical qualifications equivalent to a University Degree. Applications are not restricted to a particular field of study, but special consideration will be given to applicants desiring to enter upon post-graduate work in the United States of America. The Scholarships to be awarded will be of a substantial character and normally are intended to meet the cost of tuition, maintenance and travel of the successful applicants.

Applicants must have been resident for at least two years during the ten years immediately preceding the date of application within :

(a) The area comprising the Llanelly School District, viz. the Borough of Llanelly and the Parishes of Llanelly Rural and Pontyberem, as at present existing.
(b) The Administrative County of Carmarthen with the exception of the Borough of Kidwelly together with that part of the Parish of St. Ishmael served by the Llansaint County Primary School as at present existing, the Urban District of Burry Port and the Parishes of Tembrey, Llandefeilog, Llangendeirne and the remainder of the Parish of St. Ishmael.

In the award of Scholarships preference will be given to candidates who satisfy the requirements within category (a) above, and if there are no worthy applicants or not a sufficient number of worthy applicants to satisfy such requirements, Scholarships may be granted to persons who satisfy the requirements of category (b). Candidates must not be above the age of thirty years at the date of application for a Scholarship.

Further particulars and forms of application are obtainable from the undersigned on receipt of a stamped, addressed foolscap envelope, and completed applications must be returned not later than 18th June, 1960.

IORWERTH HOWELLS,
Director of Education.

County Education Offices,
Carmarthen. E9812 E

ADMINISTRATIVE COUNTY OF CARMARTHEN

THE THOMAS AND ELIZABETH WILLIAMS SCHOLARSHIPS

(KIDWELLY SCHOOL DISTRICT)

Applications are invited for POST-GRADUATE SCHOLARSHIPS from University Graduates and also persons possessing professional or technical qualifications equivalent to a University Degree. Applications are not restricted to a particular field of study, but special consideration will be given to applicants desiring to enter upon post-graduate work in the United States of America. The Scholarships to be awarded will be of a substantial character and normally are intended to meet the cost of tuition, maintenance and travel of the successful applicants.

Applicants must have been resident for at least two years during the ten years immediately preceding the date of application within :

(a) The Borough of Kidwelly together with that part of the Parish of St. Ishmael served by the Llansaint County Primary School as at present existing.
(b) The Urban District of Burry Port and the Parishes of Pembrey, Llandefeilog, Llangendeirne, and the remainder of the Parish of St. Ishmael.
(c) The Administrative County of Carmarthen with the exception of the Llanelly School District, viz. the Borough of Llanelly and the Parishes of Llanelly Rural and Pontyberem as at present existing.

In the award of Scholarships preference will be given to candidates who satisfy the requirements within category (a) above, and if there are no worthy applicants or not a sufficient number of worthy applicants to satisfy such requirements, Scholarships may be granted to persons who satisfy the requirements of category (b) and thereafter category (c). Candidates must not be above the age of thirty years at the date of application for a Scholarship.

Further particulars and forms of application are obtainable from the undersigned on receipt of a stamped, addressed foolscap envelope, and completed applications must be returned not later than 18th June, 1960.

IORWERTH HOWELLS,
Director of Education.

County Education Offices,
Carmarthen. E9813 E

SITUATIONS VACANT

AN OLD ESTABLISHED COMPANY, manufacturing instruments in the scientific, light industrial and meteorological fields, wishes to expand in these or allied fields. Interested in manufacturing under licence or undertaking development work on suitable projects. Assembly facilities also available. —BOX No. E2835, "The Engineer." A

ASSISTANT ENGINEERS with mechanical or electrical training required for Head Office in London. The work involves negotiation of contracts with suppliers of a wide range of processing machinery and fixed plant. Occasional travel may be involved in U.K. and abroad. Preferred age 24-27 years, and candidates should have qualifications leading to Corporate Membership of an Engineering Institution. Pension fund and free lunch facilities.—Apply to Personnel Department, British-American Tobacco Company Ltd., Westminster House, 7 Millbank, London, S.W.1. E9811 A

SITUATIONS VACANT

A. C. MORRISON (ENGINEERS), LIMITED

A. C. Morrison (Engineers), Limited, manufacturers of a wide range of specialised engine-driven generating equipment and complex associated control gear, invite applications for the following vacancies.

SENIOR SALES ENGINEER

The successful candidate should be a qualified engineer, preferably with the knowledge of small and medium-sized generating sets. He will be required at an early date, to take over responsibility for an important section of the Company's Sales activities and appropriate technical and commercial experience is therefore essential.

SALES AND CONTRACTS ENGINEER

Two Engineers are also required for general sales, estimating and contracts duties. Applicants should have a sound electrical engineering training and possess the ability to familiarise themselves within a reasonable time with the technical details of the Company's products. Commercial experience is desirable, but not essential.

The Company also manufactures various types of mechanical power units and a vacancy may exist for a candidate with sound general engineering training, particularly in the fields of small and medium-sized engines, but with limited electrical experience.

The above positions command a good commencing salary, together with membership of the Company's Superannuation Scheme after a qualifying period, and there will be scope for advancement in an expanding organisation. The work is of an interesting nature in pleasant surroundings and personal initiative will be encouraged.

Applications by letter only in the first instance stating full details of career, present salary and salary expected, should be addressed to : The Secretary, A. C. Morrison (Engineers), Limited, Town Quay, Southampton.

E9805 A

A VACANCY EXISTS FOR A MECHANICAL ENGINEER to design and erect experimental test rigs for use at low temperatures. The successful applicant will need to collaborate with scientists using the equipment in research and development projects. The research establishment is located on the Surrey/London border.—Graduates or Engineers with equivalent qualifications are invited to write to BOX No. E9751, "The Engineer." A

BELFAST FIRM of Chartered Architects and Consulting Engineers require QUALIFIED HEATING AND VENTILATING ENGINEERS and QUALIFIED ELECTRICAL ENGINEERS, preferably with experience of hospital and industrial work.—Please apply in writing, stating qualifications, experience, and when available, to BOX No. E2832, "The Engineer." A

B. O. MORRIS LIMITED,
ALBION WORKS,
465, COMMERCIAL ROAD,
PORTSMOUTH
require
TWO SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN preferably with Machine Tool Experience and Technical Qualifications at least to O.N.C. The work comprises Structural, Mechanical and Jig and Fixture Design mainly for the Atomic Energy Authority. Please write full details.

E9663 A

BRITISH CONCERN having extensive interest in Commonwealth West Africa require an ENGINEER to handle Refrigeration and Air Conditioning. Wide experience of the practical side of this work is essential, with the ability to supervise site installations and plant erection, using semi and unskilled labour. Design experience would be useful. A good starting salary is offered coupled with generous allowances and conditions of service. Details of age and qualifications, &c.—BOX No. E9743, "The Engineer." A

BRITISH OXYGEN RESEARCH AND DEVELOPMENT, LTD., have a vacancy for a MECHANICAL ENGINEER to undertake development work on pumps for fluids at low temperatures. Applicants should have a degree in mechanical engineering or equivalent qualifications and preferably some experience of pump design.—Please write to the Secretary, British Oxygen Research and Development, Ltd., Deer Park Road, London, S.W.19. E9755 A

CHIEF DRAUGHTSMAN (STRUCTURAL). Live man requires post in the above capacity, with progressive company. 25 years' experience, all branches, Estimating to Erection.—BOX No. E9833, "The Engineer." A

CHIEF ENGINEER—IRELAND

Large Commercial Undertaking in Dublin, requires an experienced Mechanical Engineer. Applicant with Oil Industry as a background would be preferred. Age 30-45. The Company has good possibilities for development. Initiative and ability to work independently and supervise Department are essential. Salary according to qualifications. Pension Scheme—Car Allowance.

Reply in confidence.—BOX No. E9735, "The Engineer." A

CHIEF PLANNING ENGINEER required by well-known engineering company in the North Kent area manufacturing components for the Motor Industry. The successful applicant, preferably aged 32-42, should have had practical experience in production machining techniques and must be of proven ability. The prospects are excellent and salary will be paid commensurate with experience. Contributory pension scheme. Replies treated in strictest confidence.—BOX No. E2838, "The Engineer." A

SITUATIONS VACANT

CHIEF WORK STUDY ENGINEER

An expanding Company in North East England engaged in small batch production of precision fabricated products for the aircraft industry, and with a developing range of new and specialised engineering activities, requires a Chief Work Study Engineer to take charge of an existing department.

The successful applicant will be a qualified engineer, preferably in the age group 30-40 with wide Work Study experience particularly in its application to Method Engineering, the control of labour, production lay-outs, the installation of incentive schemes and the transition of new products from development to pilot and full production stages.

He will be a skilled negotiator with experience of joint consultation.

A high starting salary will be paid commensurate with the importance of this appointment which carries pension and other benefits, and in which there are excellent opportunities for further advancement. Write in confidence, giving full particulars to BOX No. E9803, "The Engineer." A

CIVIL ENGINEERING DESIGN ASSISTANTS

concrete and/or steel required by Westminster professional firm for work in London. Posts carry varying responsibility are created by extended work. Amenities include staff pensions. Technical educational standard desired—graduate with design experience ; or H.N.C. with design experience. Details of technical education and previous practical experience will be appreciated.—BOX No. E9748, "The Engineer." A

CIVIL ENGINEERS

Merz and McLellan require Senior and Junior Civil Engineers for design work at Newcastle upon Tyne. The appointments are permanent, pensionable positions and are concerned with a variety of very heavy Civil Engineering construction works. Applications by letter in the first instance, bearing reference SAR, should be sent to Merz and McLellan, Carliol House, Newcastle upon Tyne, 1. E9651 A

DESIGN DRAUGHTSMAN

A vacancy exists for a top-class man to carry out prototype and production design of precision instruments. Applicants must have at least H.N.C., and five years' design experience in this field, backed by a sound workshop training. Maximum age 35 years. We expect the successful applicant to put an exceptional effort into his work, but the problems involved are interesting and cover a wide field. Prospects are good, and an attractive salary will be offered to the right man.

Write, in confidence, to Managing Director/TM10, L. Oertling Ltd., Cray Valley Works, St. Mary Cray, Orpington, Kent. E2837 A

DRAUGHTSMAN, age 25-30, required for varied chemical plant development work. H.N.C. (Mechanical) and knowledge of plant layout and pipework essential. Permanent and progressive post. Superannuation and profit-sharing schemes.—Applications to : Personnel Manager, F. W. Berk & Co., Ltd., Canning Road, London, E.15. E9796 A

DRAUGHTSMAN required for Civil Engineering Works. Experience in mechanical and marine drawing would be advantageous. Salary range £798 to £876 per annum. Contributory Superannuation Scheme ; certain railway privilege travel facilities ; Luncheon Club.—Apply in writing, giving full particulars as to age and experience, to Divisional Staff Assistant, British Waterways, "Willow Grange," Church Road, Watford, Herts, not later than Monday, 23rd May, 1960. E9788 A

DRAUGHTSMAN required for Mechanical Engineering Department, Dagenham Dock. Experience in pipe work for bulk oil installations or equipment for mechanical handling advantageous. Age over 25. Shop experience, O.N.C. or H.N.C. are requirements. Salary above A.E.S.D., Pension Fund, Canteen and Bonus.—Apply Personnel Manager, Samuel Williams and Sons, Limited, Dagenham Dock, Essex. E9695 A

DRAUGHTSMAN

Versatile Engineering Draughtsman with general experience is required by a small but rapidly expanding Engineering Company situated in East London.

The work involved includes the design of machinery, light structures, &c. O.N.C. or H.N.C. desirable.

Applications stating age, qualifications and experience.—BOX No. E2836, "The Engineer." A

DRAUGHTSMEN (senior) required by refractory engineers, previous experience desirable, on the design and detailing of incinerators, furnaces and structural steelwork. Salaries paid according to age and experience.—Write to Chief Engineer, Plibrico Co., Ltd., Westmorland Road, N.W.9. E9793 A

ENGINEERS FOR TECHNICAL ENGINEERING DEPARTMENT.—Duties include the preparation of mechanical/thermal schemes for power plant and allied projects. A good knowledge of basic thermodynamics, hydraulics and kindred subjects is essential. Experience in one or more of the following would be an advantage—(a) boiler design, (b) heat exchanger design, (c) gas turbine applications. The successful candidate will be centred in London, but will be expected to undertake short visits to site as required.—Applications, giving details of training, qualifications and experience, should be sent to Personnel Department, Ewbank and Partners, 10-11, Grosvenor Place, London, S.W.1. E9697 A

SITUATIONS VACANT

ELECTRICAL DRAUGHTSMAN

Westminster area. Professional firm dealing with large-scale industrial installations, design processes and mechanical handling. On the electrical side general draughting ability and H.N.C. educational standard. Please indicate age, education and experience.—BOX No. E9749, "The Engineer."

A

ENGINEER.—Well-known meat distributors with Head Office in London have vacancy for young Engineer as Assistant in their Engineering Dept. Applicants, preferably not over 30, must have had drawing office experience and be familiar with refrigerating requirements in small cold storage depots. Good salary and pension scheme. Write, giving age and details of experience and qualifications.—BOX No. E9740, "The Engineer." A

FOSTER WHEELER LIMITED

require a

VESSEL ENGINEER

for one of their Specialist Groups. Applicants should have at least four years' experience in the design of pressure vessels and tanks, and should be fully conversant with relevant American design codes. Some experience in the manufacture of pressure vessels is desirable, but not essential.

Applicants should apply in writing, giving a brief statement of age, qualifications and experience, to the Staff Manager, 3, Ixworth Place, London, S.W.3.

E9717 A

FURNACE ENGINEERS/ DRAUGHTSMEN

Four Senior Design/Section Leaders and eight Draughtsmen required for all types of furnaces and associated mechanical equipment as used in steelworks and non-ferrous industries.

Experience in steelworks and non-ferrous industries desirable but not essential. Salary will be dependent on qualifications and experience.

Non-contributory pension scheme.

Disturbance allowance considered.

Applications to the Director of Administration, Salem Engineering Co. Ltd., Milford House, Milford, Nr. Derby. E9807 A

J. DOUGLAS MATHEWS AND PARTNERS, Chartered Architects, require experienced RESIDENT SITE SUPERVISORS on a permanent staff basis. Applicants must be prepared to go anywhere in the United Kingdom for resident appointments of one, two or three years. Salary £1250–£1750, according to job, experience and qualifications.—Applicants to give names of at least three architect or engineer references.—Reply to 3, Ebury Street, London, S.W.1. E2840 A

O. W. ROSKILL, Industrial Consultants, 14, Gt. College Street, S.W.1, have an opening for a young CHEMIST or CHEMICAL ENGINEER, preferably with Public School and University education for training in technical market research and other consulting work. An unusual combination of scientific outlook and ability to draft well is required, together with wide rather than highly specialised interest in technological matters. E2831 A

THE GLACIER METAL COMPANY

Invites applications for the post of

SENIOR APPLICATIONS ENGINEER

The Company has recently established within its Research and Development Organisation a new department whose function is to use the latest research knowledge in advising customers on all aspects of bearing design.

An appointment has now to be made in which the Engineer will be responsible to the Manager of the new department and will have initially one assistant. The work entails a wide and interesting range of contacts in the engineering industry.

As Technology advances new mechanical designs raise new bearing problems and new bearing designs make possible innovations in the design of machinery. A senior Applications Engineer is responsible both for devising solutions to bearing problems raised with the Company by its customers and for searching out areas where such innovations are practical.

Applicants should have a good Honours Degree in Engineering, Physics or Mathematics, together with a completed apprenticeship. Experience in Research, Design or Development work would be useful.

Salary Range: £1350 to £1830 per annum.

Applications should be sent to

Personnel Divisional Manager (Ref.: SAE),
The Glacier Metal Company,
Ealing Road, Alperton, Wembley, Middx.

E9783 A

SENIOR DESIGNER required by Drysdale and Co., Ltd., Yoker, Glasgow, W.4. An excellent opportunity is open to a suitable man over 25 years of age. Applicant should preferably have experience in the design and installation of Centrifugal Pumps and their associated machinery. Life Assurance and Pension Scheme in operation. Five-day week.—Apply to the Secretary, giving full details of qualifications and salary required. E9785 A

SENIOR DRAUGHTSMAN required with experience of Pressure Vessels and general Plate Fabrication.—Apply in writing, stating age, experience and salary required, to General Manager, East Sussex Engineering Co., Ltd., Phoenix Iron Works, Lewes, Sussex. E9761 A

SITUATIONS VACANT

PATENTS

MALE TECHNICAL ASSISTANTS

required by

IBM UNITED KINGDOM LIMITED

Graduates (aged 20 to 24) in Electrical Engineering or Physics, and who have a definite interest in Electronics, will be given preference.

Selected candidates will be trained at our Head Office in London or at the IBM Laboratories near Winchester, to prosecute patent applications for inventions in the computer field. This training will eventually lead to qualification as Patent Agent.

This is an outstanding opportunity for ambitious graduates to enter a very rewarding profession. A good and rapidly progressive salary is offered together with free Life Insurance and Pension.

Applications should be made in writing to the Personnel Manager, IBM UNITED KINGDOM LIMITED, 101, Wigmore Street, W.1, quoting Ref. 60/33. E9756 A

PORT OF MANCHESTER ELECTRICAL ASSISTANT

The Manchester Ship Canal Company have a vacancy for an Electrical Assistant in the Mechanical Engineer's Department.

Applications for the position are invited from candidates, who should be not more than 40 years of age, with either a university degree or corporate membership of the Institution of Electrical Engineers and with experience in the design, layout and maintenance of electrical equipment appertaining to dock and railway undertakings. The successful candidate will be required to pass a medical examination and to become a member of the Company's contributory superannuation scheme.

Applications, containing full particulars of age, education, qualifications, experience and salary envisaged, should be addressed to the Mechanical Engineer, Manchester Ship Canal Company, Ship Canal House, King Street, Manchester, 2, not later than 4th June. Envelopes should be marked "E. A. PERSONAL."

E9744 A

POWER STATION CHEMIST ELECTRICITY DEPT., CAPE TOWN, SOUTH AFRICA

A vacancy exists in the Generation Branch of the Electricity Department of the city Council of Cape Town, South Africa, for a suitable qualified person for the position of Power Station Chemist.

The scale of pay (total emoluments) applicable to the post is £1560, with two increments of £60 to a maximum of £1680 per annum.

Applicants must possess a Degree in Chemistry of a recognised University or an equivalent qualification. They must have had experience in a power station laboratory and be familiar with the methods of sampling and analysis of materials used in a Power Station, preferably with advanced steam conditions. A knowledge of nuclear physics and the use of radio-active isotopes will be an advantage.

Persons possessing the requisite qualifications and experience are invited to apply not later than MONDAY, 23RD MAY, 1960, and to address their applications to :—

Messrs. Merz and McLellan,
Carliol House,
Newcastle upon Tyne,
ENGLAND,

from whom further particulars relating to the vacant position may be obtained.

E9650 A

PROJECT ENGINEER

A vacancy has arisen in the Development Department for an Engineer to work on varied and interesting projects from the initial design stage to final installation.

He should possess H.N.C. (Mechanical), have served a good apprenticeship and be experienced in research and development in the light and medium Engineering fields.

Machine Design experience in the Paper Converting Industry would be an advantage.

This is a Staff appointment and the successful applicant would be required to join the Company Superannuation Scheme. Canteen and sports facilities are available.

Applications stating age, present salary and full details of experience should be marked "Confidential" and addressed to: The Development Engineer, Bowater-Eburite Bulk Packaging Limited, Multiwall Sack Division, Ellesmere Port, Cheshire.

E9786 A

SENIOR DRAUGHTSMAN, May & Baker Ltd., Dagenham, Essex, require a Senior Draughtsman with experience in the design and layout of chemical or similar plant installations. Applicants should have technical qualifications to Ordinary National Certificate level or higher. Salaries are reviewed annually. There is a Pension Fund and Life Assurance Scheme in operation. Excellent canteen and sports facilities.—Apply initially in writing to the Personnel Officer, quoting Reference No. 19/60. E9732 A

SITE ENGINEER required by well-known firm manufacturing a wide range of Mining, Roadmaking and Quarry Plant. Must be capable of directing all aspects of plant erection and controlling labour.—Full details of experience, age, salary required and when available. BOX No. E9692, "The Engineer." A

SITUATIONS VACANT

THE BAHRAIN PETROLEUM COMPANY LIMITED

require

CHEMICAL AND MECHANICAL DESIGN ENGINEERS

Applicants for these positions in the above Company's Oil Refinery in Bahrain, Persian Gulf, should have a Degree in Chemical or Mechanical Engineering, with a minimum of four years' subsequent experience, covering design problems associated with liquid and gas pumping equipment, gas engines, steam turbines, heat exchangers, coolers, steam generators and boilers, piping systems, high- and low-pressure process units, together with the necessary calculations of flows, pressure drops, heat transfer factors, and the like.

The commencing salary would be in the region of £1600 per annum, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves (passage paid for the former, and generous assistance towards the latter) are also provided with participation in the Pension and Provident Fund Schemes.

Apply in writing, quoting "ETS" with full particulars, to Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1.

E9797 A

WANTED IN LANCASHIRE

ENGINEER-REPRESENTATIVE with good general engineering knowledge—especially electrical plant and pumps.—Write, stating qualifications and experience to

THOMAS MITCHELL AND SONS LIMITED, BOLTON

E9787 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

CONSULTING ENGINEERS

in Westminster

invite applications for appointments for the following staff to work in their London office on large civil engineering projects involving heavy reinforced concrete and/or steelwork design :

(*a*) ASSISTANT ENGINEERS, aged 25 to 30 years, preferably Chartered Civil or Structural Engineers with at least 4 years' experience.

(*b*) JUNIOR ENGINEERS, aged 21 to 25 years, with degree or equivalent and up to 3 years' experience.

(*c*) CIVIL ENGINEERING DRAUGHTSMEN with at least 3 years' experience in structural detailing.

Applications, giving full details of qualifications and experience to be addressed to Freeman, Fox and Partners, 68, Victoria Street, S.W.1, and marked ref. RWP.

E9790 A

SENIOR ENGINEER

for

Man-made Fibre Industry

For supervisory activities in large draughting office located abroad. Experience in machine design, cellulosic and synthetic fibre Plants. Salary £4000–£5000 p.a., depending on experience. Please reply giving full details of experience in strictest confidence.—BOX No. E2841, "The Engineer."

A

SITUATIONS VACANT

APC

ATOMIC POWER CONSTRUCTIONS LTD.

GROUP LEADER— STRUCTURES

A Leader is required at the Company's Laboratories at Heston, Middlesex, for a team engaged on experimental stress analysis of large reactor structures and vessels and on the development of reactor components. Applicants should have an engineering degree and several years' appropriate experience in development work.

Applications giving full details to :

The Personnel Manager (Ref. E/109), Atomic Power Constructions Limited,
P.O. Box No. 19,
28, Theobalds Road, W.C.1

E9791 A

SENIOR DRAUGHTSMEN

for old-established company specialising in bulk mechanical handling machinery and modern foundry mechanisation. Progressive well-paid and permanent jobs for right men. Five-day week, 3 weeks annual holiday, luncheon vouchers. (Holiday arrangements honoured.)

Apply :

Personnel Director,
MARCO CONVEYOR & ENGINEERING CO. LTD.,
Lynn Road, Leytonstone,
London, E.11.
LEY 2254.

E9734 A

AEI

MAINTENANCE ENGINEER

Applications are invited from Engineers, aged 28-40, with H.N.C. standard in mechanical and/or electrical engineering, and preferably with a workshop apprenticeship, to be responsible for Maintenance Department in a factory manufacturing electronic valves and C.R. tubes.

Experience in the maintenance of mechanical and electrical equipment and knowledge of usual factory services is required, together with the ability to control labour, preferably related to maintenance work.

Responsible post with good salary and conditions.

Apply to :

Personnel Officer,
ASSOCIATED ELECTRICAL INDUSTRIES, LTD.,
Cosmos Works, Brimsdown, Enfield, Middx.

E9742 A

BRITISH IRON & STEEL FEDERATION

Applications are invited for the post of ASSISTANT in the Market Development Department for technical and administrative work on British Standards for Steel. A technical background is desirable, preferably with qualifications, such as National Certificate in engineering or metallurgy. Interesting and remunerative work for right person.

Starting salary £800 per annum or higher, according to qualifications and experience.

Applications should be addressed to the Establishment Officer, British Iron and Steel Federation, Steel House, Tothill Street, London, S.W.1, to arrive on or before Friday, 27th May, 1960.

E9815 A

Classified Advts. continued on page 116

SITUATIONS VACANT

CENTRAL ELECTRICITY GENERATING BOARD

HEADQUARTERS DRAWING OFFICE

Due to internal promotions the Board has the following vacancies at Bankside House, Sumner Street, S.E.1:—

(A) One SENIOR CIVIL ENGINEERING DRAUGHTSMAN with design experience on reinforced concrete work.

Commencing salary within the range £830 to £940 p.a.

(B) CIVIL ENGINEERING DRAUGHTSMEN for detailing reinforced concrete, foundation and general civil engineering work. Opportunities to gain experience on design work and for upgrading as vacancies occur.

Salary £660 to £780 p.a.

(C) One SENIOR DRAUGHTSMAN Experienced on 132/275kV layout and schematic diagram work.

Salary £980 to £1080 p.a.

Also

Two EXPERIENCED FEMALE TRACERS at a salary according to experience and ability which rises to a maximum of £630 p.a.

This year's holiday arrangements honoured.

Permanent pensionable appointments.

Staff Restaurant. Sports and Social Club.

Applications stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1. Envelopes should be marked "Confidential Ref. ENR/167."

E9747 A

SITUATIONS VACANT

ENGINEER

is required at the new

CULHAM LABORATORY of the United Kingdom Atomic Energy Authority

Nr. ABINGDON, Berkshire

He will be responsible for a workshop organisation associated with the Intermediate Current Stability Experiment (I.C.S.E.) and possibly other thermonuclear research devices to be built at Culham. Duties will include the provision of a service to the Experiment for erection, modification and maintenance of the Major Experimental Plant and High Voltage Power Supplies, and for workshop service to the associated smaller laboratories.

Initially, he will be required to specify the workshop facilities and equipment —machine tools, test gear, stores, etc., and undertake recruiting and training of personnel.

The appointment will be in the engineering class at a salary range of £1370–£1825 p.a., according to experience and age.

Applicants should be corporate members of one of the senior engineering institutions and have had experience in mechanical and electrical engineering. They should have a mature and practical outlook, and a lively interest in Scientific Research.

Housing and Superannuation schemes.

Send POST CARD for application form to the Group Recruitment Officer (1659/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E9730 A

LAING

The following vacancies exist in the Research and Development Centre at Boreham Wood. The work is of an interesting nature and concerned with the development of new machines and processes connected with the Building and Civil Engineering industries.

MECHANICAL ENGINEERS AND GRADUATES

or Engineers with H.N.C. or equivalent are required for work involving the study, performance and development of the Mechanisation techniques applied within the Contracting Industry. Site experience in the operation of Contractors' Plant an advantage.

DRAUGHTSMEN

Senior and Junior Draughtsmen are required for work on the development of new and improved types of Contractors' Plant.

All these posts are permanent and progressive. Pension Scheme. Applicants should write in the first instance to :

PERSONNEL MANAGER (M.D.E.6), JOHN LAING AND SON, LIMITED, LONDON, N.W.7

E9731 A

Engineers

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Suitably qualified Engineers and Assistant Design Engineers are required for interesting and important work in the fields of mechanical, electronic and electro-mechanical development, arising from various engineering projects, including environmental testing.

POSTS 'A'

Design, development and testing of equipment to suit production and service requirements, including precision work and the development of high-voltage equipment using the latest techniques of miniaturisation.

POSTS 'B'

Environmental studies covering the effects of subjecting materials, components and assemblies to a very wide range of variations in temperature, pressure, shock and vibration factors.

POSTS 'C'

Preparation of layouts and designs to the general instructions of professional engineering staff.

Detailed working drawings are produced by other staff employed in the Drawing-Office.

These posts are of a challenging nature and offer excellent scope for individuals endowed with initiative, a progressive outlook and a lively mind. Working conditions are very good and there are excellent opportunities for advancement. Candidates should have a sound background of practical experience and be members of a senior professional institution ; for Assistant Design Engineer posts at least H.N.C. is required.

SALARY **Appointments will be made, according to age, qualifications and experience, within salary scales ranging from £860-£2180. SUPERANNUATION SCHEME. HOUSING, HOUSE PURCHASE and HOSTEL FACILITIES. FIVE-DAY WEEK. GENEROUS LEAVE ALLOWANCE.**

Send Postcard (or letter) for application form to the Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks, indicating posts of interest. Please quote Ref. : EA/25.

E9757

SITUATIONS VACANT

ENGINEERING
TECHNICAL MANAGER

A Technical Manager is required to lead and direct the Design and Technical activities—both at Home and Overseas—on the existing and new projects of a world-renowned engineering company, whose Works and Head Office are located in the London area.

This is a new post, created by the Company's continued expansion, and carries a salary of £2500–£3000 a year.

The successful candidate will also act as the Company's representative in development co-ordination, and liaise at Director level with associated Companies in the furthering of a variety of projects; execute Design Studies and Surveys on competitive equipment, establishing policy on design trends and potential markets; represent the Company on such National bodies as required by current projects; and provide technical articles on the Company's products and activities for prestige and sales purposes.

The man we are looking for must have initiative and sound, balanced judgment, allied with considerable experience in light engineering design and preferably a knowledge of modern control engineering. He must also possess an Engineering Degree or be a member of the appropriate professional institute, and be aged approximately 40–50.

Write, giving the fullest possible details of qualifications, experience, education and age, to :

Mr. N. M. Pritchard, AUSTIN KNIGHT, LTD.,
Incorporated Practitioners in Advertising,
212a, Shaftesbury Avenue, London, W.C.2.

All applications will be treated in the strictest confidence.

E9488 A

SITUATIONS VACANT

WORKSHOP SUPERVISOR
for MECHANICAL DEVELOPMENT DEPARTMENT

Must be capable of supervising a mechanical development workshop and machine shop, covering a wide variety of projects.

Experience in a Development Department in the food industry an advantage. Age between 30 and 45 years.

This new appointment carries a good commencing salary.

Non-contributory Pension Scheme.

Contributory Group Life Assurance Scheme.

Generous Canteen Facilities and other amenities.

Please write in first instance, giving full details of age, experience, present position and salary, to :

The Personnel Manager,
NABISCO FOODS LIMITED,
WELWYN GARDEN CITY,
Welwyn Garden 5100.

E9750 A

SENIOR DESIGNERS & DRAUGHTSMEN
required for
Contractors' Plant Department
of
STOTHERT & PITT LTD., BATH.

Experience in design of Concrete Mixers, Batching Plant, Vibrating Rollers, Truck Mixers or Quarry Plant an advantage, but not essential.

Extensive development programme in progress. Good salaries offered according to experience. Permanent pensionable appointment.

Write to:

CHIEF ENGINEER,
CONTRACTORS' PLANT DEPARTMENT, STOTHERT & PITT LTD., BATH.

E9763 A

THE HARLAND ENGINEERING COMPANY, LTD., ALLOA

require several

SENIOR DRAUGHTSMEN

in connection with an expanding development programme in the field of centrifugal pumps, hydraulic turbines and medium-large electrical rotating machinery.

Experience in these products, whilst advantageous, is less important than thorough knowledge of modern mechanical engineering, stress analysis, materials selection and application, and up-to-date draughting methods.

The Company offers good salaries and working conditions with contributory pension scheme, extended holidays after twelve months and assistance with house acquisition or purchase.

Replies, giving full particulars of age, qualifications and experience, will be treated in strict confidence and should be sent marked "Personal" to Chief Draughtsman, B.E.P. Works, Alloa, Scotland. E9495 A

TO
AMBITIOUS PRODUCTION MANAGERS

A worldwide group with expanding organisation must recruit an experienced young Production Manager of about 30 at around £2,000 p.a. There will be early promotion and remuneration rising to £3,000 in about six years and to £4,500 in a further four. The scope and diversity of this management position are unique. A University Graduate is preferred. Please send outline of age, education, experience and present salary to BOX No. E9802, "The Engineer."

A

NUCLEAR POWER STATION
COMMISSIONING ENGINEER

A company engaged in the design, construction and commissioning of nuclear power stations has a vacancy for a Shift Commissioning Engineer in its Commissioning Department. The successful candidate, who will be trained in the operation of nuclear power stations, must have some experience as a shift Charge Engineer in a conventional power station. He should either be an Associate Member of a major professional Institution or hold qualifications leading to Associate Membership.

Applications should be addressed to BOX No. E9764, "The Engineer," and give details of age, qualifications, experience and current salary.

A

MANUFACTURERS EQUIPMENT CO. LTD.
SUTTON ROAD, HULL, YORKSHIRE

This progressive Company manufactures an extensive range of package handling equipment, and is expanding its Technical and Commercial Departments. There are good posts open for

MECHANICAL ENGINEERS

ESTIMATING DRAUGHTSMEN

SALES AND CONTRACTS ENGINEERS

Applicants should have had a sound technical or commercial training, a good background in mechanical engineering and preferably some experience of mechanical handling equipment.

These are staff appointments and salaries will be commensurate with responsibilities. The Company offers first-class conditions of service with generous pension and life assurance scheme.

Write in confidence, stating age, qualifications, experience and present salary to the General Manager.

E9806 A

Classified Advts. continued on page 118

SITUATIONS VACANT

REQUIRED

(a)
PLANT AND MACHINERY VALUER.

(b)
ASSISTANT SURVEYOR.

For Valuation Department.

Pension scheme.

Five-day week.

Apply in confidence to:

LEOPOLD FARMER AND SONS,
46, Gresham Street,
London, E.C.2.

Telephone: Monarch 3422.

E9733 A

SITUATIONS WANTED

AVAILABLE IMMEDIATELY for Senior appointment. ENGINEER with wide and responsible experience in U.K. and abroad. Research development, Design. Flair for selecting, organising and directing projects. Some experience in Nuclear Power work.—BOX No. E2842, "The Engineer." B

AGENCIES

YOUNG, GROWING ENTERPRISE, headed by a Chartered Mechanical Engineer and a qualified Metallurgist, located Hertfordshire, is open to consider AGENCIES and other Business Propositions.—BOX No. E2934, "The Engineer." D

SWISS FOUNDRY WORKS
are looking for
GENERAL AGENT
for Great Britain.

For a most interesting new manufacturing process of slide bearings. (Very successful at the 6th European Tool-Machines Exhibition, Paris, 1959.)

Well-established firms with the necessary staff of sales engineers and technicians which are able to assure the sale of our products all over Great Britain will write to BOX S62108X, Publicitas, SA, GENEVA.

E9795 D

BUSINESS OPPORTUNITIES

ABSTRACTORS, TRANSLATORS AND EDITORS, FREELANCE, required for Russian, Czech, Polish, French and German in: physics, geophysics, metallurgy, electrical, electronic, mechanical and production engineering, aerodynamics and aviation, automation, power generation, fuel. Regular long term assignments.—BOX No. E2843, "The Engineer." O

A BARGAIN. £25 complete. BRAND NEW READY-MADE CO. REGNS. Guaranteed no trading (ENGLAND OR SCOTLAND)—all trades available NOW, including Engineering; Electrical Engineering; Motor Engineering; Garage; Machinery; Metal; Haulage; Hire Purchase; Investment; Property (specially prepared for each trade).—BUSINESS ECONOMY CO. REGNS., LTD., Dept. T/16, 156, Strand, London, W.C.2. (Tem. 8377/2294), for English companies, and to 19, Walker Street, Edinburgh, 3 (Cal. 1167/8/9), for Scottish Companies. Read "ADVANTAGES OF TRADING AS A LIMITED COMPANY" (3s. post free); Limited Co. may save you tax. We have seven-day Co. Regn. service with your own choice of name. £21 complete, plus stamp duties. E182 O

REMPLOY SPONSORSHIP SCHEME

Send for details which show an attractive proposition to manufacturers.

Write to the MANAGING DIRECTOR, REMPLOY LTD., 25-28, BUCKINGHAM GATE, S.W1, or telephone VICtoria 6621 (12 lines).

E9665 O

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and ironfoundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E751 MW

PATENTS

THE PROPRIETOR of British Patent No. 770,669, entitled "SLOTTED SCREW HEAD," offers same for Licence or otherwise to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 140, S. Dearborn Street, Chicago 3, Illinois, U.S.A. E9678 H

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

MISCELLANEOUS

LUSOL
KILLS RUST AND LUBRICATES

LUSOL The Rust Solvent is invaluable for Dismantling, Repairing and Overhauling Engineering Equipment. Obtainable from your usual Supplier. Enquiries to the manufacturers:—

The Great Eastern Oil Co., Ltd.,
372, Scotland Street Glasgow. Tel.: South 2207
E184 I

MOBILE LIFTING SERVICE. Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 78481. E186 I

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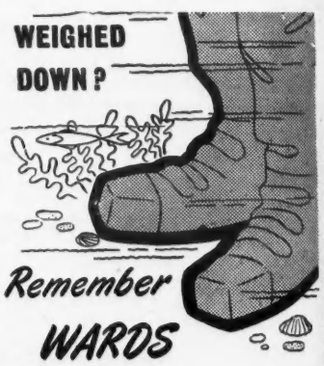

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		Main Location	Auctioneers
May 17-20	Approximately 1,900 vehicles, motor cycles, earth moving and lifting equipment.	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)

300 saloons, limousines and estate cars (including Rolls-Royce "Silver Wraith" (automatic), touring limousine by Hooper, 120 Ford "Anglias," "Poplars" and Morris "Minors"); Land Rovers, Jeeps, Austin "Champ," utilities, coaches, load carriers, 10 cwt. to 16 tons, many fitted with diesel engines (including A.E.C. "Matadors" and 6×6 refuellers, Diamond "T," International "K.R.8" tractors with 16-ton Tasker trailers, Leyland "Hippos," Mack and Scammell tractors, Thornycroft "Trusty" tractor with 14-ton stepframe Tasker trailer); vans, tippers, trailers, 10 cwt. to 20 tons, tankers, 100 galls. to 2,500 galls.; excavators—20 Ruston Bucyrus "R.B.10's," Osgood rigged crane and clamshell bucket, Priestman "Wolf's" with face shovel back acter and dragline equipment; Ransomes and Rapier Model "410"; 45 mobile cranes (some lorry-mounted); Caterpillar "D.8" tractors; road rollers; Blaw Knox towed scraper; "Sheepsfoot" roller; Blaw Knox concrete finisher; Ford snow ploughs; machinery truck fitted saw bench, lathe, etc.; wheeled tractors; trailer-mounted fire pumps; trailer and lorry-mounted diesel-electric generators (some 230 volts); Broom-Wade diesel compressor; 550 solo motor cycles by Ariel, B.S.A., Matchless, Norton, Triumph, etc., 6 and 12 volt batteries; metal truck bodies and cabs; plant ancillaries and spares by Caterpillar, Coles, Jones, Barber Greene, Bucyrus, Ransomes & Rapier, etc.

May 20	Clothing and miscellaneous stores, including:—	Command Ordnance Depot, Coypool, Marsh Mills, Plymouth. (Sale at Kinterbury House.)	WOOLLAND, SON & MANICO (Dept. L), Kinterbury House, St. Andrew's Cross, Plymouth. (Tel.: 69292.)

Greatcoats; shirts; pullovers; white blankets; tool kits; platform weighing machines; 8 gall. tubs; tyres; chain and chisel morticing machine; hydraulic sleeving press (8 tons), compressors; lathes; building materials, including ironmongery, sanitary ware, cast iron and asbestos rainwater ware, calorifiers hot water boilers and approximately 57 tons of round mild steel bar; 27 tons miscellaneous tubing; paints; electrical fittings; furniture, etc.

May 24	Miscellaneous stores.	Command Ordnance Sub-Depot, Devizes. (Sale at Corn Exchange, Devizes.)	FARRANT, WIGHTMAN & PINNIGAR (Dept. L), 2, Newport Street, Swindon, Wilts. (Tel. 5151/2.)
June 10	Machine tools and miscellaneous stores.	Technical Stores Depot, Old Dalby, Leics. (Sale at Melton Mowbray.)	SHOULER & SON (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
June 16	Miscellaneous stores and vehicles.	M.O.A. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE, LTD. (Dept. L), Bank Buildings, Graham Street, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)
June 22	Miscellaneous stores.	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.	BARTLE & SON (Dept. L), 50–52. Merrion Street, Leeds, 2. Tel.: 2.0898.)
June 30	Miscellaneous stores.	M.O.A. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)

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E118 J

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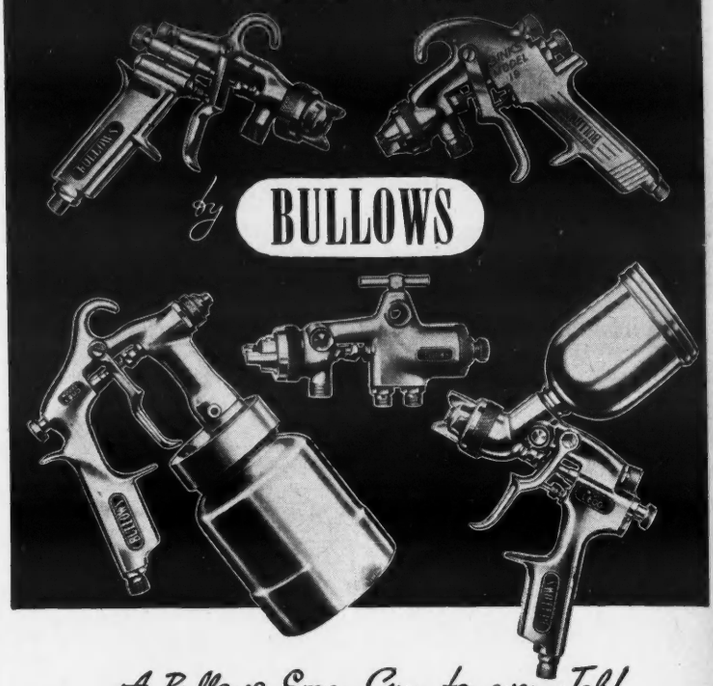

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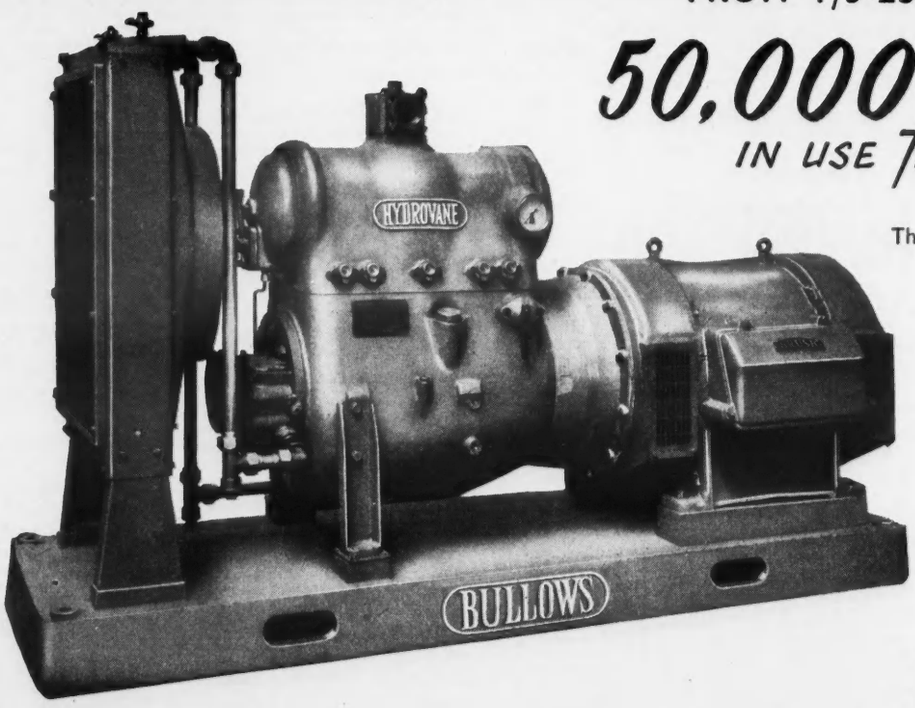

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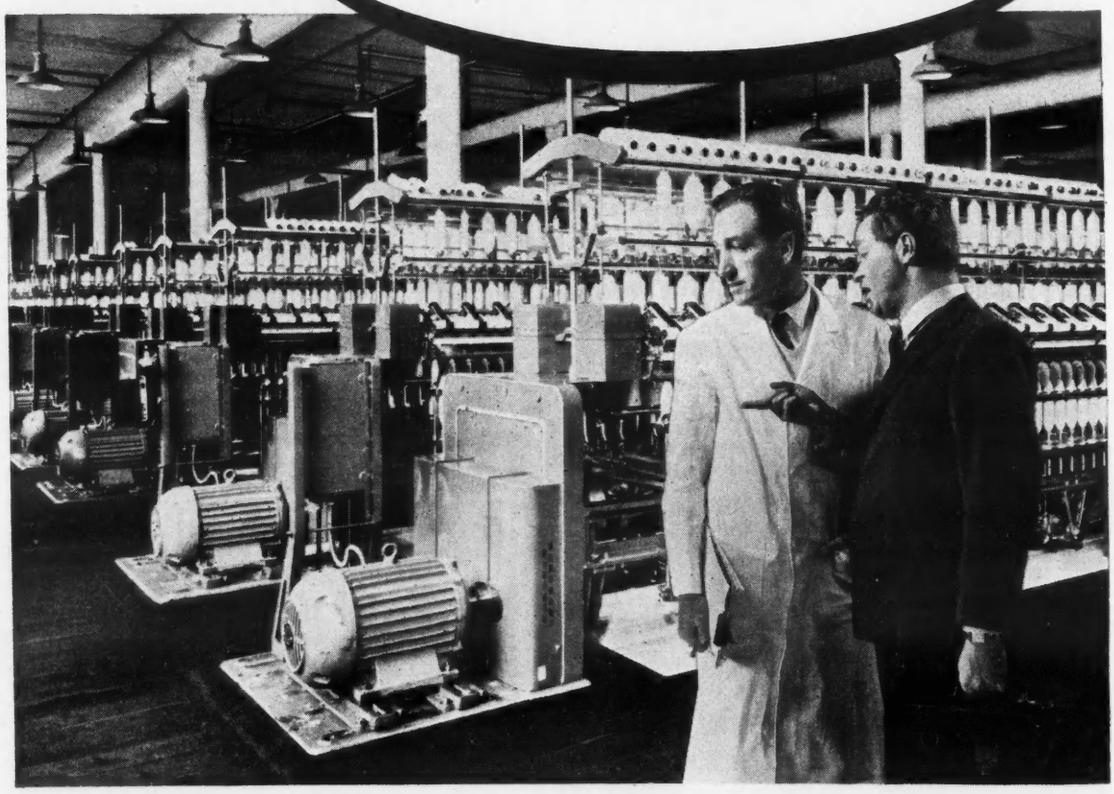

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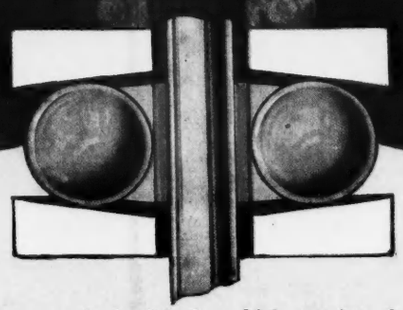

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